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M. Bagneris.

We are sorry to have received news from France of the death by congestion of the lungs of M. Bagneris, so long and well known to all promotions of old Nancy men as the Senior Professor of Forestry. Most of us still can call to mind the "Dada," whose tall figure headed the band of young foresters on tour, and expounded the mysteries of forest reproduction between the puffs of his long German pipe. He was the last of the old professors at Nancy, who are all now gone, leaving the field to a new generation, and perhaps to new teaching, which we may hope will be as good as ever. We have received a copy of the speech made, in accordance with French custom, over M. Bagneris' grave by the present Director, M. Puton, and from the information given in it, we present the following sketch of M. Bagneris' life and work:—

He was born on April 18th, 1825, at Douai, where his father was physician, and in 1844 he entered the Forest School, from which he passed out first in 1846. After having been posted during his period of probation to Strasbourg he was appointed Garde Général at Haguenau in 1847, promoted to Sub-Inspector at Bitche in 1856, and transferred to Vouziers in 1857. During his long service at Haguenau, his powers of observation and aptitude in forest work drew the attention of M. Parade, who obtained for him in 1858 an appointment to the Forest School as Assistant Professor of Sylviculture. He became Inspector in 1862, Professor in 1865, and Deputy Director in 1880. In 1876 he received the Cross of the Legion of Honour. At his death, on the 12th November 1881, he had been 35 years in the Forest service, and 23 years a Professor at the Forest School. When Messrs. Nanquette and Mathieu retired two years ago from the School, M. Bagneris was unanimously chosen by the Professors as their candidate for the Directorship, for which, however, he refused to stand, and himself gave his support to the present holder, M. Puton. He published only two works on Forestry; *first*, in conjunction with M. Broillard, a "Treatise on the Cultivation of Oak in Central France"; and *afterwards*, alone, his well known "Manual of Sylviculture," now one of the text-books of French Forest Science, which has reached two editions and been translated into German, English and Roumanian.

M. Bagneris was not a brilliant lecturer, but his teaching was sound and good, and more especially were his out-of-door lectures eminently adapted for instructing Forest students in the principles of their future work. Many of the old English students will remember him as a personal friend, many as a kind Professor willing to help them in their studies, and all as a Master, who, though not given to introducing new ideas and new methods, was yet still a safe guide, and one whose whole mind was bent on the advancement of the forest work to which he was devoted.

The Deodar Forests of the Dhauli Valley in Garhwal.

The eastern limit of the natural forests of Deodar, in the North-West Himalaya, is in the valley of the Dhauli river below the Niti Pass in Long. 19° 48′.

The tree is found further east in Kumaon, planted in temple-groves and near villages, but, as far as is known, there is no natural Deodar forest east of the Dhauli valley. It is always a matter of considerable interest to determine the distributive area of trees, which have great practical importance, and to study the circumstances, climatic or otherwise, which contribute to put a stop to the spread of such trees in a certain direction. In some cases these circumstances can readily be understood. Thus we are probably not far wrong in believing that Sal forests are not found east of Tezpur in Assam, because the moisture of Upper Assam is greater than the Sal tree can bear in the struggle for existence with other trees, which delight in excessive moisture. And its western limit in the Hushiarpur and Kangra districts of the Punjab is doubtless partly attributed to the fact, that further west the climate is too dry and too cold to be favorable for the growth of Sal. And as regards Teak there is little doubt that the natural spread of this tree beyond the hills in the Jhansi district in a northerly and north-westerly direction is precluded by the low temperature of the winter months.

It would not be easy to explain the facts which limit the spread of the Deodar eastward beyond the Dhauli valley. It may be that the climate of Eastern Kumaun and Nepal is too moist, and that this gives an advantage in the struggle for existence to the other species which are usually associated with Deodar. It nevertheless is remarkable that *Pinus excelsa*, which, like the Cedar, (the varieties known as the Atlas, Cyprus and Lebanon Cedars) is found as far west as the Mediterranean region on the mountains of Macedonia and Montenegro, forms large forests in Nepal and Bhutan.

A careful study of the character and mode of growth of the forests in which the Deodar Cedar attains its easternmost limit, is therefore a most interesting subject. I have often had a

wish to examine the forests on the Dhauli river and in its vicinity, but have never been able to find the time for such a trip. About 1866 the forests were examined by Mr. T. Webber, whom the Government of the North-Western Provinces had deputed to survey the forests in the hills of Garhwal and Kumaun. Mr. Webber's reports are extremely voluminous and not readily accessible.

Last summer, while at Dehra Dún, I found that Mr. E. Litchfield of the Forest Surveys, had, in former years, while employed in the Great Trigonometrical Survey, spent a considerable time in the Dhauli valley and in its vicinity. I accordingly suggested to him to put together from his notes a brief account of the forest vegetation in that part of the country. His paper will be read with interest, and the excellent map with which he has accompanied it will, I trust, prove useful to many a forester who may be so fortunate as to visit those regions.

A trip to the forests and glaciers of the Dhauli and Pindar rivers, would, I feel sure, be a great pleasure and an excellent change for foresters, especially for those who labor in the heat of the tropical provinces of India, in Burma, the Central Provinces, Madras and Bombay.

D. B.

MADRAS, *7th January* 1882.

Memorandum on the Forests met with on the roads between Almorah and Joshimath, and on the Dhauli river between Joshimath and Malari village.

There are two routes from Almorah to Joshimath—one up the Kosi river to Sameswar, and then over the hills to Baiznáth; and the other round by Bageswar and up the Gumti to Baiznáth, where the two roads unite and go on to Gwaldum. At Gwaldum the road again divides—one road following the course of the Pindar to its Junction, at Karnprag, with the Alaknanda, the main branch of the Ganges, and then going up the latter to Joshimath. This is the easier and the most generally used of these two roads, but is hot and confined. The other road, which diverges at Gwaldum, crosses the Pindar at Bathleswar, and cuts across the hills *viâ* Mandauli, Wán and Rámni, crossing the Pilkhanta range, near Joshimath, at Kúari pass, 12,400 feet above sea level. This road is rather steep in many places, but is much shorter than the other one, and affords a good view of the country on both sides.

There is not much forest near Almorah; the surrounding hills are covered with villages and cultivation. Following the road to Baiznáth, *viâ* Háwalbagh, Cheer is met with all along the banks of the Kosi. The forest improves as Sameswar is approached, and thence on to Baiznáth the hills on both sides

of the road are covered with fine big trees. Oak occupies the top of the hills above the Cheer forest.

On the road to Bageswar the Cheer forest commences on the north side of the Kálimat range. Binsur hill is covered with a dense forest of Oak. On the steep descent on the way to Thakla, there is a dense forest of young Oaks, Rhododendrons, &c. Between Thákla and Bageswar, and all the way on to Baiznáth, the hills are covered with very fine Cheer forests. Between Baiznáth and Gwaldum, the road again passes through Cheer, until near the top of the Gwaldum pass, where, I think, the forest becomes mixed Oak, Cheer, Rhododendron, &c. Descending the north side of the Gwaldum range towards Jwálabagar, Cheer is again met with near the Pindar. The slopes of the hills on the right bank of this river are covered with splendid forests of Cheer, which extend down the whole length of its course and up the Alaknanda to Pipalkot. In fact these forests stretch in a belt from Pipalkot on the Alaknanda to near Kúari on the Pindar. They are all good forests, close to the banks of the rivers, and the hills are not very steep. I do not remember any precipitous hills where the Cheer forest grows; and the Alaknanda and Pindar are both fine rivers capable of floating large logs. I think that almost, if not quite as far as Kháti, the Pindar is practicable for floating timber.

The Mandauli and Rámni road enters the Cheer forest between Gwaldum and the Pindar, and leaves it near Mandauli. Beyond this place I do not think there is any more Cheer; the forest becomes a mixed one of Oak and other trees, but chiefly Oak I think. At Wán there is a clump of young Deodars which, very probably, have been planted by the villagers. Between Wán and Dombiti the trees are chiefly *Abies Smithiana* and *Webbiana*, and Oak on the lower spurs and in the valleys. Just below Dombiti the growth is very dense. Above Dombiti the hill sides are bare, or nearly so, and the road up to the pass is very steep.

With the exception of the Cheer forest between Mandauli and the Pindar, I do not recollect any valuable forests on this part of the road, but Mr. Webber shows a large forest of *Abies Smithiana* and *Webbiana* and Cypress on the left bank of the Nandak Ganga. At the point where it is crossed by the road this river is not large enough to float timber.

From the peak near Kúari pass a very fine and extensive view of the surrounding country is obtained. To the north-west and north are the peaks at the sources of the Alaknanda, and those on the great watershed which separates the Mana and Niti valleys—the highest peak on this range being Kamet, 25,443 feet. To the north-east a portion of the Niti valley is visible; and to the east are the peaks of Dunagiri, 23,184 feet, Nanda Devi, 25,669 feet, and Tirsal, 23,406 feet. These three

peaks are respectively north-east, and south of the Rishiganga valley. The glaciers in this valley cover an area of about 35 square miles, and very nearly surround the peak of Nanda Devi which stands out most prominently. The beds of snow in this valley are of great thickness, and avalanches and loud reports are of frequent occurrence. The river issuing from the glacier is a roaring torrent which dashes down between perpendicular walls of rock. The only entrance to the valley is by a path up the spur from Lata village, or round by Tolma and over a pass about 16,000 feet. This path is almost impassable when there is snow on the ground.

Descending from the Kuari pass towards Joshimath, the road passes through a very fine mixed forest of Kharshu, Moru, *Abies Smithiana* and *Webbiana*, *Pinus excelsa*, Oak, &c., and a few Deodar near Joshimath. Opposite Joshimath, on the right bank of the river, there are some trees which I think are *Pinus excelsa*. The whole hill side on the left bank of the Dhauli is covered with a very fine mixed forest which stretches from Joshimath to the Rishiganga. Near Tapoban is a beautiful forest of Hazel, Maple, Birch, &c., very dense and close.

Scattered here and there, all along the banks of the river between Joshimath and Malari, are clumps of Deodar. The trees appeared to me to be rather stunted, but some of them are of great girth, particularly one near Tolma, which was pointed out to me as a curiosity. It is a well known tree, and is generally visited by travellers who pass that way. There are some scattered trees at Suráithota; they are all, I think, small trees, and extend only a short way up the hill side which, on the right bank, is very steep. There is a mixed forest containing, I think, a little Deodar, on the slope above Lata village, between the village and the base of the precipice overhanging it. Above Tolma, on the way to the Rishiganga valley, there is a dense forest, a part of which, I believe, is Deodar; but I may be mistaken—the trees may be *A. Smithiana* and *Webbiana*. Near Jilám, and also on the opposite bank near Kaga Ruing, and on the banks of the stream which flows past Dunagiri, there is a good mixed forest which also contains some Deodar. Between Dunagiri and the glacier there is some Birch and Rhododendron.

At Bhujani, south of Malari, there is a good forest of Fir and Oak, and I think Deodar and *Pinus excelsa*. The banks of all the streams which flow into the Dhauli are clothed with forest for a short way up their courses. There is not much forest in the Rishiganga valley. The banks for some distance up are wooded. The right bank not much so; but on the left bank is the continuation of the forest mentioned as existing between Joshimath and the Rishiganga. Owing to the precipitous nature of the ground the forest in the Rishiganga valley is not available.

The hills in the Dhauli valley are all steep, and in many places very precipitous and rocky; and the obstructions in the river would, I think, render floating out of the question.

A good hill pony may be ridden as far as Malari, and perhaps even farther up. The Bhutia traders, with their heavily-laden ponies, zibboos and goats, travel along this road to and from Thibet without much difficulty.

I think the Dhauli has fewer and less dense forests than the Pindar valley. There are very good forests about Khati, and also up the river almost to the foot of the glacier. Near Khati the forest is chiefly Kharshu and Moru, but higher up there are very fine forests of Fir. The road is good as far as Khati.

Attached is a map on the scale of 8 miles to the inch (reduced from the one-inch maps of the G. T. Survey) showing the country between Almorah and the Niti pass.

E. LITCHFIELD,
Assistant Conservator, Forest Surveys.

CAMP SITARGANJ, 18*th November* 1881.

The Teak Forests of Java.

It is astonishing how rapidly progress is being made in different Colonies, English and others, in the conservation of forests and the organization of a special department for their management. The latest addition is in Java, where the Netherlands Government have established forest work, chiefly with the view of preserving the Teak forests. And we are, therefore, much indebted to Messrs. Slym and Hill, of the Burma Forest Department, for an account of these forests, drawn chiefly from the pages of "De Djati-Bosschen," a recently published work by Mr. J. W. H. Cordes, Inspector of Forests in Java :—

The Teak forests of Java were of considerable extent two centuries ago, but they have gradually been destroyed in clearing land for the cultivation of coffee, sugar, &c. At the beginning of the present century the demand for Teak for house and ship-building was still considerable, and in the construction of Fort William 150,000 logs were used, and as many more wasted as undersized or otherwise unfit for the work. Large areas of Teak forest were destroyed during the war of 1825 and 1830.

The wholesale destruction of the Teak forests first attracted the notice of Government in 1859, and orders were issued directing the survey of the remaining forests—a work which was completed under difficulties in 1871. The result of the survey gives the area of teak-producing forest at 6,000 square kilometres, or about 2,160 square miles.

Roughly, the half of this area belongs to Rambaug, by far the richest forest district. In the districts of Bantam, Bangormas, Bagelen, and Kedoe, there are no natural Teak forests, and only a few small plantations have been attempted during the

past four years. The Teak areas are not unfrequently small and surrounded by cultivation, and here and there only a few old trees are found dotted about, often serving to mark the site of a grave, and respected in consequence.

Up to 1856 artificial means were employed for reproducing Teak with but little success; but between that date and 1864 some 500,000 young trees were raised in plantations, and 200,000 near public offices and guard houses.

About this time, too, Government ordered that expenditure on forest operations should be confined to the preservation and improvement of the natural teak-producing tracts.

Changes in the administration, and the fact of the forests being in the hands of the civil authorities, prevented the wholesale destruction of Teak forest from being effectively checked until 1864. In 1854 the Home Government sent four young men to be trained for three years in Germany, and these proceeded to Java in 1857; but no regular Forest Department was formed till 1865. Rules were then framed for the management of the forests, but no penalties for infringements were imposed until 1875, when new rules were promulgated, any breach of which was punishable by fine or imprisonment. At this time the Forest Staff was increased to 217 officers and subordinates.

Up to 1880, or during the fifteen years that a proper forest administration has been in existence, 10,000 hectares (24,710 acres) of the old Teak forest have been exploited and planted up with young trees.

Mr. Cordes says of jungle fires in Java: "The inhabitants fire the forests:—(1), for sanitary reasons; (2), to facilitate traffic; (3), to drive off wild animals; (4), for amusement or from mere habit. Fires do not, however, always originate within the forests, but are often communicated to them from outside by people burning high grass in clearing for cultivation.

"Very young Teak seedlings and seed lying on the ground suffer less from rapid running fires than young saplings of the height of the grass.

"Fires in the vicinity of Teak forests were prohibited as far back as 1857, and the resolution is yearly proclaimed; but still there is great difficulty in preventing the yearly recurrence of the jungle fires.

"Forest fires in Java do not work the same destruction as they would in colder climates; standing trees, if not hollow or decayed, are rarely injured. The fires as a rule run fast, and as the flames are near the ground, they only consume the dry grass and dead leaves. If, however, there is a calm and the fires go on smouldering for a considerable time, fed by fallen and dead trees, they may cause considerable damage to the growing stock, as well as to the logs which are invariably found lying in a Teak forest.

The damage caused by jungle fires is counterbalanced to some

extent by the following advantage : *viz.*, that the heat has the effect of splitting up into crevices the hard clayey soil and rendering it penetrable to the roots, at the same time favouring the admission of air and moisture in quantities."

From Mr. Cordes' book it may be concluded that, with a strict conservancy and extensive planting operations, Java will again rise into importance as one of the main sources of supply of teak timber for the European markets.

Hirda Revenue in the Kolhapur State, and the Method of Collecting it.

The few scattered growing Hirda trees, that are found to be still surviving in the Ghát forests of the Kolhapur State, seem rather to have accidentally escaped the hands of the unmerciful Koomri cutters, than to have been purposely spared to grow for the sake of their fruits, before any attempt at forest conservation was made three years ago; for the trees appear to have suffered from injuries incidental to non-protection, such as fire, grazing, &c., to such a degree as to render them unfit to bear any healthy seed and to reproduce themselves by natural means.

It seems probable that the remains of the Hirda trees owe their present existence to the fact of their being able to grow on grassy and isolated plateaux, perhaps better than most other vegetation similarly situated, and where the ravages of Koomri cutters have been less frequent than on the outer slopes and sheltered ravines. The reason is, that the ground on the plateaux being exposed to the prevailing storms is invariably overgrown with rank grass, and covered with scrub-growing trees, and bushes of a scattered growth, rendering the soil unsuited for the requirements of Koomri cultivation. Such places have been inhabited by herdsmen, who have free access to the ground to graze their cattle with no restriction whatever; whereas on the outer slopes and sheltered ravines, the ground is all that could be desired for the purposes of Koomri cultivation. It is densely covered with forest vegetation, which contributes to the formation of a new layer of vegetable mould by the decomposition of the fallen leaves and dead branches, and to put down the grass and other weeds by keeping the soil in perpetual shade. Such places are resorted to for the purpose of Koomri cultivation by persons of indolent habits, the object being to save the trouble of preparing the ground for sowing and ultimately of weeding.

The only thing the Koomri cutter is required to do here is to cut down all the tree growth, and burn the material to obtain ash manure, which, with the humus soil underneath, forms an admirable receptacle for the seed without the trouble of loosening the surface soil, as is done in the case of the

ground exposed to the action of the sun before being utilized for Koomri purposes.

In spite of the advantage possessed by the Hirda tree in being able to grow beyond the sphere of Koomri cultivation, it seems that the tree was hardly in a position to outlive the ravages of other enemies, such as fire and cattle, the combined action of which have contributed to the extinction of most of the forest vegetation on the Western Ghats and other hill ranges in the Deccan districts, and rendered them barren in a more or less degree.

The evil effect arising from the forest denudation became apparent long ago, even on a cursory glance, as is noticed in the July number of the "INDIAN FORESTER;" and, though this fact, or the utility of forest conservation, was then scarcely recognised, yet Government found means to do something to save the remnant of the forests from further destruction, and *arrest the mischief before it was too late. No systematic* measures were, however, adopted in that direction until 1870.

In native administrations the destruction of forest property has been more deplorable, as nothing was done to induce them to do something towards forest conservation until recently. Fortunately for the Kolhapur State, its internal management during the minority of the prince has been in the hands of an enlightened Karbhari (Minister), who, knowing the beneficial effect arising from the forest conservation, took the matter up and organised a special department in 1878, presided over by a native forest officer at a cost of about Rs. 20,000, exclusive of the working charges, on the same footing as that adopted in the adjacent British districts.

The chief duty, which at present devolves upon the Forest Department in Kolhapur, consists in the formation, maintenance and improvement of the State Forest domains, which have been so devastated that it will take some time before they are rendered capable of yielding any revenue by the sale of their produce, and of contributing at least a share of the expenses required to be incurred in maintaining the *department.*

Indeed the grass proceeds of the Kuran lands transferred to the control of the new department for the purposes of being planted with trees, amounted to about Rs. 20,000; but it was argued by the Revenue authorities of the State, and perhaps rightly too, that the Forest Department cannot claim the grass revenue as its realization was to them a matter of no difficulty, nor did it require any professional aid.

However, the new Forest Department in Kolhapur consented to have what, in the opinion of the Revenue authorities, is fairly due to it; and resolved upon endeavouring, at the cost of any trouble, to develop the resources of the minor produce of the jungle until the tree properties of the State are made capable

of yielding any timber, and wood material generally. With this view, it directed its attention to the protection of the surviving Hirda trees, and to the propagation of new ones either by coppice growth, seed regeneration or artificial means. And this could only be done by securing the good will of the wilder tribes by meeting their legitimate wants as far as possible or practicable, and consistent with the reforms, which were about to be introduced in the matter of forest conservation.

By such proceeding the new Forest Department succeeded in protecting a considerable area of forest land against fire and cattle, and saving the Hirda trees from being burnt when in flower.

Such of the Hirda trees as were growing thin, and as had become diseased by constant burning, were allowed to be lopped under supervision to aid in the formation of a new crown overhead *of strong and healthy growing branches, and to render* them capable of bearing healthy seed, which, owing to its defective character, was dropped down by violent storms during the rains, and allowed to rot in the wet grass. The object of such pruning was simply to influence the production of flowers and to secure more yield in quantity of Hirda fruit, and it was carried on continuously for three years. In the month of April 1880, the department found itself in a position to submit proposals, embodying a scheme for the departmental collection of Hirda fruits, together with the subjoined estimate, showing the probable yield in quantity, the revenue likely to be obtained by the sale of the nuts, and the expenditure required in collecting the same, &c., during the fruiting season of 1880-81, *viz.*, from 1st June 1880 to 31st May 1881 :—

Years.	Estimated yield of the Myrabolams in khandis.	Estimated value @ Rs. 40 per khandi.	Estimated cost to be incurred in collecting.	Net profit expected to be realized.
		Rupees.	*Rupees.*	*Rupees.*
1880-81	1,200	48,000	14,000	34,000

Note —One khandi of the Kolhapur measure is equal to 1,960lbs.

Thus it will be seen that within such a short period as three years an increase of Rs. 29,800 was anticipated over the amount of revenue, *viz.*, Rs. 4,200, hitherto realized, when the right of collecting Hirda was farmed out. However, the State authorities entertained doubts as to the accuracy of the estimate; but considering the honesty of purpose with which the Forest Department was actuated in that matter, they sanctioned its proposals in connection with the Hirda collection.

The procedure adopted in giving effect to the Hirda collection scheme was :—

That a notification and handbills were issued to the ryots directing them to deliver over all the Hirda fruits, which might be collected by them from the State forest reserves to any of the depôts established for the purpose on payment. The inamdars and others having right over the Hirda trees were exempted.

That depôt stations were fixed in the Hirda producing district at a distance of about four to six miles from each other, so that the people residing in the intermediate villages had only to go from two to three miles to deliver over the Hirda nuts.

That the patel, or village officer at each of the depôt stations, was appointed to take charge of the Hirda depôt, who was allowed two per cent. on the sale proceeds after paying the expenses. He was also allowed the services of one Karkun for keeping the depôt accounts in the prescribed forms. The services of the village Mahars (watchmen) were retained to keep a watch on the quantity of Hirda collected in each depôt on payment of Rs. 10 as a reward in lump sum. In this way the patels and others were induced to take interest in the success of the new scheme.

The ryots were paid at the rate of eight annas per maund of the Kolhapur measure, or two annas and three pies per maund of 560lbs. throughout the whole season. In some of the British districts the ryots are paid at higher rates as the collecting season advances. In some they are paid for the carriage when the depôt station is more than three miles from their residence, but by so doing great temptation is offered to defraud Government. If the object is simply to compensate the poor ryots, it is better to pay them even at a higher rate throughout the whole season. In this way the ryots will be induced to collect a larger quantity when they find that they are well paid for their trouble.

Those who required money in advance were allowed small sums up to Rs. 5, through the Forest Rangers, assisted by the Mamledars, Divisional Karkuns, and in the presence of the respective village patels, taking their signatures on the list prepared in the prescribed form, which was attested by the signature of the patel. Those who were unable to collect Hirda through illness, &c., returned the balance due by them.

A yellow pass was granted by the depôt-keeper for the quantity of Hirda received by him, on each occasion, from the person who took money in advance. The passes were periodically collected by the Forest Ranger in the presence of the village patels, and an entry was made in the ledger, showing the quantity of Myrabolams delivered on different dates at each depôt by all persons to whom money was advanced, and after

comparing the figures with those entered in the pass books kept at the depôts the accounts were squared.

At each depôt two registers were kept; in the one stock received every day at each depôt from persons to whom money was advanced was entered, and in the other the quantity of Hirda delivered by persons who did not take any advance, but were paid on the spot, was entered. The totals of these two registers were made up every day, so as to keep the stock account ready for inspection at any time.

In the cash book account of the money paid by the depôt-keeper, as per details entered in the stock registers to the persons having received no advance was entered, and the cash balance in hand at each depôt was shown.

The stock account was submitted by the Forest Rangers to the Forest Conservator at the end of each month.

The required forms were printed, bound in books, stamped and supplied to each depôt-keeper.

The services of such Forest Rangers as had not to do any Hirda collection work in connection with their own ranges were made available to assist other rangers in the Hirda producing ranges, in keeping a watch over the doings of the depôt-keepers, and examine their accounts instead of employing temporary establishment, their duties being conducted by other subordinates.

Thus one responsible officer was made available for employment in each of the river valleys. The Conservator, too, kept a good watch by constantly patrolling the Ghât forests, visiting the depôts, and keeping an eye over the doings of his subordinates.

In this way the department succeeded in nearly realizing its expectations. The subjoined table gives the actual yield in Hirdas, prices obtained, and the net profit remained after deducting the actual expenses during the fruiting season ending on the 31st May 1881 :—

Years.	Actual yield of the Hirda in quantity.			Prices obtained @ Rs. 36 per khandi.	Actual cost incurred in collecting.	Net profit realized.
	Khandis.	Mannds.	Payali.	Rs. As. P.	Rs. As. P.	Rs. As. P.
1880-81	954	12	2	34,365 13 2	10,633 11 6½	23,732 1 7½

It will be seen that the quantity of Hirda actually realized fell short of the estimate by two hundred and forty-six khandis, which was owing to the unusually heavy and continued fall of the rains during the Hirda collecting season, which caused a large quantity to rot in the wet grass; otherwise the yield would have been the same as estimated for, though there may have been an increase or decrease in the money value, for

which the Forest Department cannot be held responsible, because the prices are regulated according to the demand in the market.

The forest demarcation in Kolhapur has made considerable progress, and when it is once completed, and the forests brought under a thorough protection and re-stocked with new growth, which is being done, it is believed that the Hirda revenue of the Kolhapur forests will gradually, but steadily, increase, and perhaps within the next ten years reach one hundred thousand rupees. The satisfactory result of the past year's collections seem to warrant this estimate.

The system of collecting the Hirda fruits departmentally tended to make the Forest Department in Kolhapur more popular than is usually the case, as sufficient employment could be afforded to the wilder tribes, who never even see grain as their food for some months in a year owing to their poverty, and who toiled in vain to maintain themselves by carrying on Koomri cultivation at the sacrifice of forest vegetation, and who now see that the existence of the new department is for their own good and welfare.

There are other advantages arising from the above system which will be dwelt upon on some future occasion.

NATIVE FORESTER.

The Cape Forest Department.

THE Cape Government have taken lately an important step towards the proper arrangement and management of their forests—a step which we hope is not too late. We have much pleasure in publishing a translation of some extracts from a letter received by a correspondent from the French Forest Officer who has lately been appointed to report on the Cape Forests and propose measures for their organization and management. The Officer selected, we believe partly through Col. Pearson at Nancy, was M. le Comte Vasselot de Regné, late Inspector at Poitiers. From correspondents at the Cape we learn that at present at any rate his appointment is temporary only, and that when he has inspected the forests and written his report he will return to France. But perhaps the Cape authorities may find it possible to persuade him to stop and carry out himself the reforms he proposes. And it seems that the Conservator expects some such arrangement, as he has taken his family with him to Wynberg, and as the pay of the appointment, £700 per year with £100 for house rent, may tempt him to stop if the prospects of a pension are also added :—

* * * * *

As I already have written you, we have had a very good voyage. On arrival we were obliged to pass a dozen days or

so at an hotel, and at last we settled on taking a house at Wynberg, where we are sufficiently comfortably established. Wynberg is about three-quarters of an hour from Cape Town, and there are trains almost every hour, so a great portion of the officials and business people live there. I have got my office there in my house as a temporary arrangement. The houses are all surrounded by gardens which touch one another, mixed with groves of pines, which put one in mind of Arcachon. The sea shore is too far off for a walk, but the mountain is close behind us.

* * * * *

As soon as I got settled, I set off to explore my forest districts. The principal forests in the Colony are found in the district of Kingma, two days' march from Morel Bay. They are managed by Captain Harrison, Conservator. They contain one very valuable tree, the stink wood, which in its qualities resembles the oak, but it only makes up about four per cent. of the contents of the forests. There is also plenty of yellow wood, which is the silver fir of these parts. There are also several other species which are more or less utilised. Licenses are issued to persons applying for them to cut wood in the forests; and consequently every one takes what suits him best, without reference to any other consideration. When a block of forest is supposed to be used up, it is closed for felling, and left in a wretched state of disorder. The conservancy of Kingma comprises at least 200,000 acres of forest lands, of which about half is really valuable. It is in the best order of any of the Cape forests.

From thence I went to visit the forests in the Alexandria and Port Elizabeth divisions. They are under a Ranger, who exercises the duties of Conservator, but who really does nothing at all, except issue licenses, and now and then send in a statement of accounts. Further east is the division of King Williams Town; there the forests are less extensive, but more valuable. They are managed by the Baron de Fin, an old officer of the German Legion, now 84 years old, but so hale and vigorous that he still goes on horseback into the mountains. In the divisions of Stockenstrom, and Victoria East, which are next to those of King William's Town, the forests are managed by a Ranger as in Alexandria. Near Cape Town the sands are being planted, for which there is a Superintendent of Plantations.

The Colony is traversed by ranges of mountains totally bare of forests. It suffers often from drought. As far then as can be estimated after a rapid survey, the forests of the Colony may be estimated at 800,000 acres of woodland of all sorts, of which about 200,000 acres are fairly good forests, the rest chiefly small wood. Besides this, there are at least ten million acres of mountains and plateaux, which are capable of

being planted, and would be immensely enriched by it. The whole is divided into five districts, which ought to be separate Conservancies. The service is under the Minister of Crown Lands and Public Works, with whom I correspond.

Examination of Soils at Dehra Dun. Notes of work in the Chemical Laboratory.

The following soils were mechanically separated by washing with water, into coarse particles, fine sand and the finest particles of silica and clay. The different substances were weighed by Mr. Mendes and the percentage calculated :—

1. *Soil from the Forest School compound.—Percentage: Sand* 91 ; *Clay* 9.—The first washings (51 per cent of the soil) consisted of a mixture containing mostly *debris* of slate and quartz, the slate having the same colours as the slate rocks of the sub-Himalayan ridge close by.

2. *Soil from a field at Dehra Dún.—Percentage: Sand* 68 ; *Clay* 32.—The first washings (32 per cent of the soil) consisted of slate *debris* and quartz. The slate *debris* are of the same description as in No. 1.

3. *Soil from another field at Dehra Dún.—Percentage: Sand* 87 ; *Clay* 13.—The first washings (40 per cent of the soil) consisted of the above *debris* with some sand.

4. *Potters' clay from Dehra Dún —Percentage: Sand* 27 ; *Clay* 73.—The first washings (6 per cent of the soil) consisted of quartz and slate *debris*, the same as in the former soils. The sand was clean red sand.

5. *Soil from a pot in the forest garden, Chakrata.—Percentage: Sand* 27 ; *Clay* 73.—The proportion of sand and clay identical with No. 4. The first washings (27 per cent) consisted of fine red sand ; the rest was strong clay.

6. *Soil from the Saharanpur division (Sivaliks).—Percentage: Sand* 81 ; *Clay* 19.—The sand washed off this soil consisted of clear quartz grains.

7. *Soil from Ajmere (brought by Mr. Moir).—Percentage: Sand* 87 ; *Clay* 13.—The first washings consisted of fragments of mica schist (distinctly recognizable) and of some sand amounting to 30 per cent of the soil.

In the above mechanical analyses all those portions were reckoned as sand which formed masses of particles which did not bake together on drying. Those portions which formed cracking cakes on drying were considered as clay. Some portions of washings, the particles of which adhered very slightly together after drying, were reckoned as sand with 5 or 10 per cent of clay. In most cases the sand and clay were entirely distinct.

Soil No. 5 was analysed qualitatively *in toto* by treating with hydrogen chloride, and melting the undissolved portion with potassium carbonate. The soil was found to contain silica, some alumina, much ferric oxide, traces of lime and traces of magnesia.

The amount of moisture in Bamboos, Bakain (*Melia Azedarach*) and Sal (*Shorea robusta*) was determined by heating specimens in a steam bath for long intervals, to nearly the temperature of boiling water, and weighing them repeatedly until there was no more appreciable, or scarcely any appreciable, loss of weight.

(1.)	*Bamboos*, air dry, but during the rainy season September, 1881, amount of moisture represented by loss of weight...	...	12 per cent.
(2.)	*Bakain* felled a fortnight before	...	37 „ „
(3.)	*Sal, air dry, in September 1881.*	...	18 „ „

The specimens were burnt, and the amount of ashes roughly determined. Calculated on the artificially dried wood (steam-bath) the amount of ashes roughly determined was as follows:—

	Ashes.
Bamboos	(not weighed).
Bakain	3 per cent.
Sal (a carefully selected clean piece) ...	0·4 „ „

The soluble portions of these ashes were examined with the following results:—

Bamboos.—Pure potassium flame. Potassium carbonate with less chloride and sulphate.

Bakain.—Pure potassium flame. Potassium carbonate with less chloride and sulphate. Some lime was also in the solution.

Sal.—Sodium flame. Still probably most potassium.

The insoluble portion of the Sal ashes was treated with hydrogen chloride. A residue was left, containing the silicon, which was however not specially proved.

Further, the presence of calcium and magnesium was proved, both in large quantities, but specially the latter. Further a considerable quantity of the phosphates of iron and aluminium was separated and verified. Besides the aluminium phosphate some aluminium hydrate was also separated, but the quantity was small, so that it might have been derived from the China vessels used in the process of analyses. Manganese was shown only in the minutest trace by the green coloring of a soda bead before the blow pipe.

Mr. Hutchins' Rain Gauge.

Mr. Hutchins has asked us to publish the following two letters from him to the Meteorological Reporter to the Government of India, and we have much pleasure in doing so :—

No. 1, *dated Bangalore, 5th September* 1879.

With reference to Government of India orders, dated Simla, 28th June 1879, I have the honor to inform you that the gauge I am directed to forward to you consists of two cylinders of sheet zinc—one constructed like an ordinary gauge, except that it is longer, being of a length to retain the maximum quantity of rain which might fall between any two observations; and the second similar to the first, except that it is much shorter and adapted to give the measure of the evaporation only taking place in the first cylinder. For this purpose the second cylinder is like the first, but furnished with an umbrella-shaped cap which excludes all rain while permitting the free circulation of air to the funnel. Placed in position the conditions of the two cylinders are identical, except that rain is admitted to the first cylinder and excluded from the second; evaporation goes on equally in both. The first cylinder gives rainfall *minus* evaporation; the second evaporation only.

The diameters of the cylinders are such as is convenient for reading with a graduated glass measure and of a convenient size with regard to the height; mine are 8 inches.

To set the instrument: a known quantity of water is placed in the first cylinder A, say one inch, to ensure constant evaporation till the first shower falls; at the same time the second cylinder B is filled with water. To read the instrument: the rainfall since last observation equals the depth of water in the first cylinder A *plus* the loss by evaporation read from the second cylinder B. The height of water in each cylinder can be read approximately and very rapidly with a graduated slip of zinc painted black with white figures. Black or dark grey paint shows the water-line best.

When greater accuracy is required, or if the cylinders are badly made, the water in each is measured in the usual way with a graduated glass vessel.

It has occurred to me that the returns from taluk cutcheries might be checked by adding one of my instruments and having it read by any responsible officer at his periodical visits, he taking the reading rapidly from the zinc scale. This would, at any rate, prevent or detect the absurd mistakes which have been made (tenths sent in as inches, and certain showers left out of account altogether) which has had the effect of preventing any meteorological value being attached to these observations.

I remember some years ago visiting one of the taluk cutchery gauges, and finding it kept in a building; they were in the

habit of bringing it out and catching any rain that fell during office hours.

It is the interest of plantation mèstris to make the rainfall appear less (apart from the fact that their observations would never obtain credit), and it was this that first led me to try and find a gauge which I could read myself.

The evaporation from the second cylinder is small, and I expect to obtain a factor which, within limits, will enable one to dispense with its use. At the same time, as furnishing an index of the evaporation, for stated periods, at selected points, it is of interest with regard to tree vegetation. For instance, at 4,000 feet the atmosphere here during the monsoon is nearly saturated with moisture. At 3,000 feet on the Mysore plateau the atmosphere is very rarely unpleasantly damp and never for more than a few days together. At 3,000 feet, with an elevation of 1,000 feet above the plateau, it seems to be as damp as at 4,000 feet. For 70 miles within the Western Ghâts the atmosphere is sensibly damp and more favourable to tree life, especially during the hot season.

The tops of both cylinders are locked with brass letter padlocks. Both cylinders are imbedded in a mound of stones, earth, &c., turfed over: first to prevent excessive evaporation from solar heat; second to prevent the instrument being disturbed. Any malicious tampering with the instrument to make the rainfall appear less becomes then discoverable.

In the improbable case of any one being interested in endeavouring to make the rainfall appear more, it would be easy to supplement each large cylinder with two or three smaller ones, with known small diameters, as checks, in which case any one desirous of tampering with the gauge by adding water would have to do so in the ratio of πr^2 for each cylinder! The advantages claimed for this instrument are that it enables one to obtain a knowledge of the total rainfall, accurate within a tenth of an inch, and of the total yearly evaporation, under the conditions—these two factors being the important ones to tree life.

I have no leisure to undertake a long series of accurate observations, and any meteorological observations from a forest officer being necessarily subordinate to his regular work, there could be no expectation of their regular continuance. What I aim at now is to obtain some *relative* factors of rainfall and evaporation at certain points, under different conditions: first, of forest vegetation; second, of elevation; third, of situation, *i.e.*, with regard to distance from the Ghâts, east or west, and of the neighbourhood of hills, such as occur in parts of the plateau, and among which all the central forests of any value are situated.

In other words, the monsoon-borne rainfall varying from year to year, the *relative* precipitation and evaporation from

place to place is a nearly fixed quantity, and may be arrived at with two or three years' observations.

Another point on which I wish to get some reliable figures is "*drip.*" *On cloud swept hills I have observed it going on* all night long, under trees during the day in the monsoon, and in the open country it occurs during the fogs of the cold season.

This is, of course, quite apart from rainfall: and, except to foresters, is interesting more than important, although it has repeatedly found a place in windy reports of the influence of forests on rainfall. The coffee in this province is all grown under forest, and the consideration of "drip" is one of the first things a planter thinks about in regulating his shade.

Again there are two opinions with regard to the action of stomata bathed in dry air, so good an authority as Sachs holding one view and later experimentalists another. Any reliable figures with regard to the relative humidity of the air in forests would bear on this subject at once.

Another point of interest is whether the rainfall is greater in the Cantonment of Bangalore than in the nearly treeless plain around. It was stated, I believe, before the Famine Commission, that such was the case, and from my own observation, constantly driving in and out during the monsoon, I believe that it is so; but there are no figures on the subject. Bangalore stands on the edge of a sharp drop in the plateau (600 feet in ten miles) on the south-west side, from which most of the clouds come, and is well placed for noting the effect of a mass of scattered trees in condensing cloud. Further east occur the Government plantations, small but compact masses of trees, in some of which my gauges have been placed. In the hill forests, north, south and west of Bangalore, I have them at 5,000, 4,000, 3,000 and 2,000 feet elevation, and reading these at times when I have to visit them on duty, I hope to get comparative data for each quarter of the year. These will compare with the means which have been taken for a long series of years in the Government Observatory in Bangalore, 3,000 feet above sea level.

I have added a drawing which may perhaps be found sufficient. The instrument itself is bulky, and would cost more to pack and send to Northern India than it is worth. At Calcutta it could be made up better than I can get the work done in Bangalore.

The cost of these gauges here with the zinc scale, but without a graduated vessel, is about Rs. 7.

No. 2, dated Bangalore, 25th April 1881.

SIR,—I have the honor to acknowledge the receipt of your letters showing the comparative reading of the rain gauges. I am much obliged to you for the trouble taken, and shall be happy to have the results published as proposed.

The correction noted in the last letter I have applied, as directed, to the first table sent. This serves slightly to increase the error in the reading of my gauge. Apparently, the evaporation is greater from the *modified* form of evapometer than from the rain-gauge vessel; and if this is so, my original form of evapometer might give closer results. Indeed, looking at your table it appears that the approximation would have been nearer had the evapometer been neglected altogether. I here assume, from an inspection of the table, that four inches was the standard quantity of water in both vessels at the beginning of each month. All I have been able myself to attempt, in the way of testing the instrument, was to compare during rainless weather the loss by evaporation in each vessel. Absences on duty, showers, and leaky vessels have vitiated my figures. Where I could get a few correct observations the evaporation from the two vessels seemed to vary little. My experience has been that the liability to leak is a fatal objection to the instrument, in that form, especially where it has to be left without attention for a year at a time. It is liable also to injury from animals, and to occasional fouling* of the water, in the receiving vessel, by insects, which influences the evaporation. Lastly, there is no proof that the gauge has not been tampered with, and I know that some of my instruments, left apparently abandoned in the jungles, have been tampered with. To get over these difficulties I have put the instrument into a different form. Glass is the only convenient material quite above suspicion in the way of leakage, and I therefore employ three bottles of a size to hold a gallon each in place of the two tin vessels. One of these bottles is the evapometer with the pipe leading from it, closed with a cap, as before. The cap is of the same size as the funnels, but A-shaped and placed at a lower level than the funnels to guard against the splashing up of rain drops. The other two bottles are receivers and have funnels as before. These three bottles are packed in a strong box or small barrel of teak, or other wood properly tarred, and sheathed at the bottom with zinc.

The lid of the box or barrel shuts down and locks, leaving three funnels coming through the lid from the neck of each bottle. Being thus more compact and strong it is less liable to injury from animals butting and rubbing against it. The fouling of the water and the detection of tampering are provided for by the receiving vessel taking the form of two bottles. Fouling does not often occur, and it is not likely to happen to both the bottles of an instrument; but the great advantage of a double receiving vessel is that it affords

* The fouling is increased by the high temperature of a tin vessel exposed to the sun.

the means of immediately detecting any tampering with the gauge. The funnels leading to the two receiving bottles are of slightly different diameters, arranged so that the receiving areas of each funnel bear a single proportion to one another, say as 2 : 3. The contents of both bottles being measured, the readings, if correct, will be as 2 : 3. If tampered with by the class of persons who would tamper with a rain gauge, it would be next to impossible to add water to, or take water from, the gauge without interfering with this proportion. The two funnels of the two receiving bottles have receiving areas respectively of 7·854 square inches (= a diameter of 3·17 inches) and of 11·781 square inches (= a diameter of 3·86 square inches). Now 7·854 square inches + 11·781 square inches = 19·635 square inches, which is the area of the funnel of the ordinary 5-inch gauge. This permits the use of the ordinary glass measurer by multiplying the figures from the small funnel bottles by $\frac{2}{5}$; those of the large funnel bottles by $\frac{3}{5}$.

The funnels are fixed in the stoppers by casting a plug of lead round the funnel pipe, using the glass stopper of the bottle and a lump of clay as the pattern and mould.

I have not been able to procure larger than half-gallon bottles in Madras, and if one has to send to England for gallon bottles, it would increase the expense of the gauge. But gallon bottles are used for importing and storing chemicals and could probably be procured in Calcutta. Gallon bottles will register up to 22 inches rainfall. (Receiving area of largest funnel 11·781 *square inches.* Gallon contains 277·274 cub. inches $\therefore \frac{277\cdot274}{11\cdot781} = 22\cdot7$).

Ordinarily I do not think it will be practicable to procure larger than gallon bottles, and a rain gauge for forest purposes should, if possible, be one made of materials procurable in the country. Nearly every purpose would be answered by a gauge which would register the year's rainfall within a quarter of an inch, and, in many situations, accuracy within an inch would be enough for practical requirements. By halving the receiving area of the rain gauge to one-half that of the standard 5-inch gauge, it would register up to 45 inches, so that only one observation would be necessary in most places to take the year's rainfall ; and this is a necessary condition for a forest gauge which often can only be conveniently read once a year during the fair season.

I should esteem it a great favor if you would favour me with your opinion as to how far the accuracy of the gauge would be affected by reducing the reducing area by one-half.

Measurements of Planted Mahogany Trees at Akyab.

By J. N.

During 1838 to 1842 a few seedlings of Mahogany were forwarded to the Commissioner of Arakan to be planted out in Akyab as an experiment. About this time the Civil Officers stationed there took great interest in the planting of trees, and especially Casuarina, Mango, Teak, Pynkado, Pynmah, *Cassia siamea and timorensis*, Figs, *Melia Azadirachta*, *Spondias mangifera*, *Terminalia belerica*, *Hopea odorata*, *Dillenia indica*, *Calophyllum inophyllum*, &c., so that most of the road sides to the south of the main wharf, in the old cantonment, are lined by trees exceedingly grateful to the eye during the rainy and the cold seasons.

In 1867, Dr. Anderson, of the Botanical Gardens, Calcutta, called for a report on the then existing Mahogany trees, which was submitted by the Commissioner of Arakan (Colonel Ryan) in the tabular form hereto appended. The ascertained data of 1867 are printed in roman character.

Recently the Commissioner of Arakan (Colonel Sladen) called upon me for a report on the trees, and the measurements made on 12th September 1881 are those printed in the statement in

italics. It will be observed that the figures of 1881 in the height column in a few cases fall below those of 1867; but as the latter were admittedly only approximate, while those fixed by me were determined by the aid of Fleischmann's Spiegel-Hypsometer, the discrepancies are easily to be understood.

As the trees stand generally in isolated positions, the full and graceful branch development has of course been carried out at the cost of the bole, which is in almost every case excessively short. Probably plantations, in which the development of bole was aimed at by close planting (except along with a slightly slower growing, strong, shade-casting evergreen), would not be successful, as the trees are exceedingly "kittle" in the matter of interference by the branches, or shade, of any neighbouring tree.

All Akyab is flat, and the soil is sandy alluvium.

These Mahogany trees yield seed abundantly, which germinates readily.

Tabular Statement of the measurement of Mahogany Trees (Swietenia Mahagoni) growing in Akyab, taken on the 22nd October 1867.

And again on the 12th September 1881.

Distinguishing number of each tree.	LOCALITY.	MEASUREMENT OF EACH TREE.										REMARKS.
		Circumference.								Length of Bole.	Extreme height approximately	
		At 1 foot above the ground.		At 4 feet above the ground.		At 5 feet above the ground.		At 6 feet above the ground.				
		Ft.	In.	Ft.	In	Ft.	In.	Ft.	In.	Ft.	Ft.	
1	In front of Dr. Mountjoy's former residence, now occupied by Mr DeOliveiro.	..	...	2	7	...	..	...	...	4	15	A road drain 2 feet deep, within 8 feet of the tree. A Casuarina tree within 18 feet, besides other small shrubs.
1	*"Akyab Press" Offices Compound* ...	*5*	*10*	*5*	*3*	*6*	*2*	...	...	*5'6*	*46*	*Interfered with in growth on north by a dominating Casuarina trunk, damaged.*
2	At the south-west angle of Mr. Polacco's Compound in Phayre Street.	.	...	..	...	...	...	...	...	2	10	The stem of this tree is very crooked; 2 or 3 jungle trees are close by, 2 drains 3 feet deep, at the distance of about 5 feet to the south and west. *This tree is not now traceable.*
3	In the centre of Mr. Gerber's Compound	..	...	4	8	4	7	5	5	6/3	61	There are no drains close by, the nearest tree 43 feet distant.
2	*In Messrs. Burot Gerber & Co.'s Compound to north-east of house.*	*7*	*9*	*7*	*1*	*7*	*4*	...	...	*5'6"*	*48*	*Stands isolated, branch development unit ifold.*
4	In Circuit House Compound, east side in front of Circuit House, left hand of north entrance.	...	...	4	6	4	3	4	3	8/4	60	The surface road drain is about 20 feet distant. There are 2 trees close by—the first 4 feet and the second 17 feet distant.
3	*Hospital Compound, east side to left hand of north entrance.*	*3*	*2*	*6*	*11*	*6*	*10*	*6*	*11*	*9*	*60*	*Close to a small road drain. Growth free and uninterfered with by other trees*
5	Ditto ditto ditto right hand of south entrance.	..	.	6	1	6	8	...	...	5/6	60	Ditto ditto. There are 2 or 3 trees close by, the nearest 11 feet distant.
4	*Hospital Compound, east side, to right hand of south entrance.*	*3*	*7*	*3*	*9*	*10*	*1*	..	...	*5'6"*	*60*	*Growth free only towards the west side.*

6	Do. north side close to the fence, right hand of the north entrance.	...	...	5	2	5	10	...	...	5/6	65	The road drain 4 feet deep runs within 4 feet of the tree; 3 or 4 branches of the tree were lopped off this year. The nearest tree 16 feet distant.
5	*Hospital Compound, north side to trees down from Laumadaw in Phayre Road.*	7	1	7	...	7	4	..	..	5'6"	57	*Uninterfered with in growth.*
7	Do. west side close to the fence, north of the west entrance.	...	..	3	11	4	..	4	3	6/3	45	The road drain 4 feet deep runs w thin 8 feet of the tree; 5 or 6 branches of the tree were lopped off this yeas. The nearest tree 16 feet distant.
6	*Hospital Compound, west side, second tree from Phayre Road.*	5	11	5	8	5	7	6	8	6'6"	47	*Isolated tree in line of trees on road side.*
8	Do. do. close to the fence south of the west entrance.	..	...	4	3	5	2	..	..	5	42	The road drain 4 feet deep runs within 8 or 10 feet of the tree; the surface drainage of the compound runs by the foot of the tree. There is a Bamboo 16 feet distant. The tree has had 2 or 3 branches cut, one of which was a main branch above the bole.
7	*In Laumadaw (Hospital Compound, west side) opposite to Messrs. Paul Auschitzkey & Co.'s Office.*	6	2	6	10	5	5	5	3	14	45	*Tree grouth only to east and west; dominated on sids by a Casuarina.*
9	In Lower Cantonment Road to the opposite side of the road before Mr. Hind's residence.	...	...	6	6	..	...	..	..	4/4	35	The road drain, a foot deep, runs within a foot of the tree; 2 or 3 branches of this tree were lopped off this year *This tree is not now traceable.*
8	*On road, fourth tree to west of Mr. Schmidt's house.*	5	10	5	7	6	4	..	..	5'6"	36	*Isolated tree at road side.*
10	In Lower Cantonment Road to the west side of Mr. Hind's house.	...	...	2	11	3	...	..	..	5,6	20	The road drain a foot deep runs within a foot of the tree.
11	In Buddermohan Road in Mr. Dunn's Compound, formerly owned by Mr. T. Shepherd.	...	..	3	3	...	..	...	..	4/6	20	The road drain about 18 inches deep runs within 3 feet of the tree. The earth about roots is raised about 18 inches above the general level of the compound.
9	*Cardwell Compound to right of entrance*	6	7	6	6	...	...	...	...	5'	39	*Isolated stand; with manifold branch development.*
12	Outside of the Jail Garden fence ...	.	...	3	6	..	...	...	..	4	20	The road drain 3 feet deep runs within 5 feet of the tree; 5 or 6 of the branches were lopped off this year. *Not now traceable.*
13	Do. nearly opposite the foregoing tree across the road on the land owned by Asmut Ally, Duffadar of Police.	..	...	2	4	...	..	...	..	4/3	15	The road drain 2 feet deep runs about 5 feet distant. The surface drainage of the land passes within a foot of the tree. *Not now traceable.*
10	*Messrs. Paul Auschitzkey & Co.'s Compound.*	5	7	6	2	7	3	..	..	5'	55	*Growing among Cassia Siamea.*
11	*Ditto ditto ditto* ...	5	7	5	6	6	...	..	6	6'6"	43	*Ditto ditto.*

Note on the Lac Industry in the Sonthal Pergunnahs (1881,) by C. J. Manson, Esq., Deputy Collector.

When the lac insect (*Coccus lacca*), or, as the natives call it, *lakor laka*, was first introduced into this district is not known, but there is a concurrence of opinion that the Paharias were the introducers, or at any rate the first cultivators of it, and the industry is known to have existed in some parts of the district for the last 40 or 50 years. The insect is supposed to have been introduced from Manbhoom, but this must be only a surmise, since the date of its introduction is not even approximately known. Lac is a cellular resinous incrustation, secreted by the insect round the branches of various trees, having a colour varying from a deep orange to a dark red according to the tree on which it is produced. It contains from 60 per cent. to 70 per cent. of resinous lac, and 10 per cent. of a dark red colouring matter which is manufactured into lac-dye, the remaining 20 or 30 per cent. being refuse.

Lac, as turned out by the manufacturers, is termed *shell-lac*, known to the trade by various names, such as *orange-leaf*, manufactured principally at Mirzapore in the North-West; *reddish orange livery leaf* and *button*, manufactured at Ilam Bazar in Beerbhoom, and by the Ranchee Lac Company at Ranchee in Chota Nagpore; and *garnet lac*, manufactured in Calcutta.

Lac, as sold by the growers, is termed *stick-lac*; and a there are no manufactories in this district, it is with this raw material that we have to do.

Lac is cultivated in all the sub-divisions of this district, but most extensively in tuppah Handwai, in the sudder or Dumk

sub-division, and which is nearly in the centre of the district. In this tuppah the original, and still the principal, seat of the industry is taluk Kesri, which alone yields the zemindar a revenue of Rs. 2,000 a year from the lease of groves of trees for the cultivation of lac. Besides taluk Kesri, lac cultivation has long been known in the villages of Kainjor in taluk Nadia, Jartal in taluk Singui, and Ashanbani in taluk Baji, all within the tuppah of Handwai.

Haripur, the market town of Kesri, is still the chief business centre of this trade, although the industry has now spread to all parts of the sub-division. Its holding its own against the head-quarters town of Dumka is due, not only to its being the birth-place of the trade, and its still being in the centre of the chief producing area, but because the exports being chiefly made to Mirzapur through Baidyanath station on the Chord line of the East Indian Railway, it is a more convenient centre for accumulating stocks, being only 43 miles from the station, whereas Dumka would be 48. The other markets in the sub-division for lac are Kumrabad, about five miles south-east of Dumka, Sareyahat 28 miles north-west, and Nunihat 17 miles west-north-west of Dumka.

Although lac has been produced here for the last fifty years, it is only within the last nine or ten years that the industry has developed into an important item of our export trade.

I am not in a position to give accurate figures of the yield of the lac crops of past years; they might be compiled from the East Indian Railway records with some degree of accuracy, but the following statement of the principal traders' managers here, as reported by Mr. W. M. Smith, the Sub-Divisional Officer, shows sufficiently the extensive development that has taken place. He says:—"When I came here first, about eight or nine years ago, the annual crop was from 500 to 600 maunds. The last Bhadro crop (1880) yielded 16,000 maunds in the Dumka sub-division, the Boishak crop (May 1881) about 6,000 to 7,000 maunds, and the present Bhadro crop (October 1881), which is not so good as last year's, is estimated at 10,000 maunds."

The annexed statement of lac exports from the Baidyanath station, obtained by the Sub-Divisional Officer, Mr. S. S. Jones, C.S., shows that the above figures cannot be very far out. Some of the produce is exported by road to Ilam Bazar in Beerbhoom, some no doubt finds its way to the Loop line *vid* Amrapara, Hiranpur, and Pakour, some towards Godda and Bhagulpore, and some towards Manka and Raneegunge; but to balance this there is the local produce of the Deoghur sub-division about 2,000 maunds, and some small amount drawn from the Godda and Bhagulpore side. There are also small exports of lac trade, I am told, from the Muddapore station, but no figures are obtainable.

Statement of Stick-lac despatched from Baidyanath Station, East Indian Railway, during 1880-81.

Month.	Year.	Quantity.		Year.	Quantity.	
		Mds.	Srs.		Mds.	Srs.
January ...	1880.	264	30	1881.	5,434	20
February ...		25	0		615	10
March		.....			96	20
April		.....			429	10
May		114	0		1,206	10
June		200	30		381	0
July		2,229	20		408	30
August		2,007	0		613	0
September ...		721	30		455	20
October		573	30		.....	
November ...		3,213	30		.....	
December ...		2,912	0		....	
Total ...	...	12,252	10	...	9,640	0

Mr. W. M. Smith, the Sub-Divisional Officer of Dumka, has also obtained figures from the zemindar of tuppah Handwai, showing his receipts from the groves of trees leased out for lac growing, which still further exemplify the rapid expansion of this industry :—

In 1285 (1878) his receipts were			Rs.	227
„ 1286 (1879)	„	„	„	455
„ 1287 (1880)	„	„	„	4,112
„ 1288 (1881)	„	„	„	3,000

The figures obtained for 11 other estates in the Dumka subdivision are as follow :—

1285	...	...	Rs.	2,232
1286	...	...	„	2,488
1287	...	...	„	3,669
1288	...	...	„	4,488

and these include Kesri, in which the increase has only been Rs. 151 on an original revenue of Rs. 1,871 ; so that the development in areas to which the industry has only recently extended is from Rs. 361 to Rs. 2,466 ; and no doubt the same ratio of increase has been obtained in the rest of the subdivision.

The lac industry was no doubt stimulated in this district by the increasing demand that arose for the article in the London and United States markets in the years 1873, 1874 and 1875, the consumption of lac having been nearly doubled between

1870 and 1876. The price of lac was at its greatest height in 1873-74, since when it has declined again; the impetus given to the industry by the high prices having resulted in producing more lac than there was a demand for, the surplus stock in 1876 being more than a whole year's demand This was partly caused by the manufacturers adulterating the lac with common American resin in order to keep pace with the demand. Before the production of lac increased, this adulteration is said to have been carried on until it reached from 50 to 70 per cent. The fall in prices that took place after the increased demand had stimulated the production into overstocking the market is no doubt the cause of a falling-off in the cultivation reported from Godda and Pakour; but with a steady trade both production and consumption will increase, and already this year prices are again improving.

Throughout this district, with the exception of Pakour, lac has hitherto been cultivated only on the *palash* (*Butea frondosa*), Santali, *muru*. It is said, however, that it spreads itself to other trees in the neighbourhood of the *palash* groves.

In Pakour it is said that the cultivation is principally carried on on the native plum tree or *bair* (*Zizyphus Jujuba*), Santali, *jamun*.

In the neighbouring district of Beerbhoom it appears to be principally cultivated on the *pipal* (*Ficus religiosa*), Santali, *hesa*, a common enough tree here, but the lac is of inferior quality to that produced on the *palash*, which is a more plentiful tree than the *pipal* and one of the characteristic trees of the Sonthal Pergunnahs. It may be known to some as the "flame tree" from its masses of bright reddish orange flowers.

This tree appears to rise spontaneously from the ground, and is now being extensively preserved, so that the district is ready to meet almost any demand that could arise for the article.

The best lac is, however, said to be that produced on the *kusum* (*Schleichera trijuga*), Santali, *baru*, on which it is, I believe, largely cultivated in Chota Nagpore. This tree is also common enough here, but I understand that the insect producing lac upon it is not the same that we have here. Our insect varies between red and yellow, whereas the *kusum* insect, or, as it is called, *naguli*, is solely red.

The *kusum* crop of lac appears also to be later than that from *palash* or *bair*, being from middle of May to July, and middle of October to January; whereas the *palash* and *bair* crop is from middle of March to May, and middle of August to October. The lac from *palash* is only very little inferior to the *kusum* lac, and at the same time it produces the deepest dye.

The seasons for setting and gathering the lac appear to be the same throughout the district.

There are two crops, the first in Cheyt and Bysakh, corresponding with middle of March to May; the second Bhadro to

Assin, corresponding with middle of August to October. These crops, however, go by the name of Jeyth and Kartick, those being the months when the crop is in the local market.

Lac is cut before the larvæ swarm, the colouring matter being a portion of the female insect's body. Most of the colour would be lost if the insects were allowed to leave the cell before cutting; some portion of the lac would also be lost by their breaking through the covering of the cell.

The crop of Cheyt-Bysakh yields the most and best lac, whereas the crop of Bhadro-Assin contains a greater proportion of colouring matter.

The manner of setting the insect for the next crop is simply to save a few well-covered twigs, or a branch of the tree when cutting the crop, so that the new shoots thrown out by the tree being pruned down in the removal of the crop may be covered by the insect when it swarms, which for the Jeyth crop is in Kartick, and for the Kartick crop in Jeyth, corresponding with middle of October to November, and middle of May to June.

To set the insect in a new grove of trees a branch of healthy lac containing the larvæ is tied in each tree.

After the larvæ have swarmed the branches that were left or tied on the trees are cut and the lac sold; this lac goes by the name of *Phunki*.

The mode of preparing the crop for the market is primitive in the extreme, and must result in considerable loss of material, especially of the colouring matter. Where the incrustation has formed on thick wood, it is scraped off with the reaping-hook or some other such rough instrument; where it has formed on thin wood, the parts wholly covered are left intact; where it is only partially covered, the uncovered portions of wood are roughly cut off, so that a large amount of wood or stick is sold with the lac, hence no doubt its name of "stick-lac." The cultivation of lac, as before stated, was formerly confined to the Paharias, with whom the zemindars made their own agreement as to rent to be paid for the trees. At the recent Sonthali settlement the rent per tree was fixed at two pice, that is, Rs. 3-2 per hundred; in many villages the groves of *palash* now contain several hundreds of trees.

It may be said that all castes have now taken to producing lac, of which the most numerous are Paharias, Sonthals, Bhuiyas, Khetoris, Goalas, Bauris, and a sub-division of the Kadar caste in Godda called Leas. Several persons generally combine to work a lac garden, as watch has to be kept, lac thefts being not uncommon.

The growers generally sell to the village mahajun or shop-keepers: sometimes taking advances on the crop; sometimes exchanging the produce for salt, tobacco, and such like; and sometimes being paid in cash. Although the crop is no doubt

a very paying one, the growers generally do not seem to improve their condition by it. To this there are some notable exceptions amongst the better castes. The growers are said to have obtained only Rs. 3 to Rs. 4 per maund for lac some few years ago. It then ran up suddenly to Rs. 27, Rs. 28, and even Rs. 30 near the railway; and then fell again to Rs. 12 and Rs. 13, and Rs. 8 and Rs. 9 per maund for last season's crop.

The village shop-keepers, who purchase from the grower, make a profit of from 10 to 20 per cent.

As Calcutta is the place of export for lac, a great saving might be made if sticklac were taken direct from this district and worked up there instead of its being taken to Mirzapore, a place about 350 to 400 miles from this, and then conveyed all the way back to Calcutta about 500 miles.

I have said nothing on the manufacture of lac, as it is not manufactured in this district: a very good article on this subject for Chota Nagpore is to be found at page 406, No. 6, Vol II of the *Satistical Reporter* for November 1876.

IV. Notes, Queries, and Extracts.

The following extract from the speech of the Dewan at the assembly of Representative Ryots and Merchants in Mysore, held on October 7th, 1881, will be interesting:—

"The forest revenue which alone has shown an increase is, as already remarked, chiefly derived from the sales of sandal. In recent years, there has been an increasing demand for sandal, especially for sandal roots used for the manufacture of sandal oil. It has, therefore, been practicable to sell larger quantities and to realize higher prices than before. But the sales do not admit of unlimited expansion, as the markets for sandal will not take more than a certain quantity annually; but it is hoped to keep up the present sales, and in order to meet them, attention is given to the conservancy of the sandal preserves. As the sandal grows largely on private lands, the holders of which at present possess no interest in preserving the trees, it is under contemplation to revive the rule once before promulgated for allowing a commission to landholders on the sandal grown on their lands and delivered to Government.

"The other items of forest revenue are quite inconsiderable as yet. The several descriptions of building-timber growing in the forests, valuable as they are, cannot be worked with any great profit unless the cost of felling and carting could be considerably cheapened. As an instance, it may be mentioned that, although there was a large demand for timber in connection with the railway to Mysore, it was found cheaper to get Rangoon timber from Madras than to use the timber of our forests, except to a small extent at the Mysore end of the line. This was the case especially in regard to the railway sleepers. Creosoted pine sleepers, which are considered superior to the teak for this particular purpose, were brought all the way from Europe by sea and by the railway from Madras, and were delivered at Bangalore at cheaper rates than our teak sleepers could be supplied for, and with a rapidity which cannot be hoped for in our forests. The work on the railway would in fact have come to a standstill if it depended on our forests for the supply. When the country is opened out by railways it is hoped to work the forests to greater advantage and with scientific appliances.

"The various descriptions of jungle products will also receive attention at the same time, and the forests will be managed with decidedly more profit than at present.

"The extensive scrub jungles along the line of the railway to Mysore have, however, been turned to profitable account for the supply of fuel to the railway which had been in the first instance obtained from the Kuppam jungles in Madras.

"The forests altogether ought to be made a great source of revenue to the Government, but this cannot be done unless they are strictly conserved, which is not altogether agreeable to the people who have been hitherto accustomed to use them indiscriminately. What is everybody's property can be of use to no one. The ryots, however, have strictly no rights in these jungles which in most cases are not situated within the limits of their villages. There ought, therefore, to be no hardship in making them look to their own lands and to the small tracts of jungles which are proposed to be assigned to their villages for any supplies they may stand in need of, and to make them pay moderately for anything required from the *Government forests. Arrangements will, however, be made to* throw open the pastures in these jungles to cattle at stated times and under proper arrangements."

THE MANUFACTURE OF WOOD PULP.*—Wood pulp, which has of late years acquired some importance as a substitute for rags in the manufacture of coarse and fine papers, is obtained in two different ways:—(1), mechanically, by the mechanical disintegration of wood; (2), chemically, by treating the wood with chemical re-agents.

1. *Preparation of cellulose by the mechanical method.*—Wood lately felled and stripped of its bark is ground between heavy millstones beneath the surface of running water, passing thence through a sieve or bolter, as a fibrous mass, which can be used, with or without admixture of rags, as a substitute for ordinary paper pulp. The wet mass of woody fibre is deprived of its superfluous moisture by pressure, and in that state is sent to the paper-mills. This compressed fibre, even when boiled, will not give a fine-grained paper, for which purpose an addition of 25 to 80 per cent. of rags is necessary. Wood paper acquires a yellowish or greyish tinge with exposure, for which reason also it is unsuited for finer purposes. Wood fibre is not pure cellulose, but contains a mixture of intercellular substance, which has held the plant-cells together. Pure cellulose forms 30 to 60 per cent. of ordinary wood pulp. Wood pulp is very short in the fibre, owing to the method in which it is prepared, whereas pure cellulose is longer in the fibre, felts better, and is more suitable for paper-making. Wood pulp is therefore employed for the coarser sorts of paper, whilst the chemically prepared cellulose is well adapted for the finer kinds.

* Translated from Dr. Theulus' *Das Holz und seine Distillations-Products*, Vienna, 1880.

In 1871 some experiments were made by O. Meyh, of Zwickau, in regard to grinding wood after steaming it in steam boilers. The results were most satisfactory, and the method is now used in the fabrication of brown papers. Independent experiments were made about the same time by E. F. Meisner, of Roth-Damnitz, near Stolp, Pomerania, in the boiling of wood with and without caustic lye, grinding, and preparing paper from wood fibre obtained by the first method, with and without an admixture of rags. A partnership was concluded between H. Voelter and O. Meyh for the working of certain of these new processes, which are now known in Germany as the Voelter-Meyh patent. Aug. Erfurt, manager of the wood pulp and paper works of Bezner & Co., endeavoured to improve the process by the ebullition and prolonged immersion of the wood in soda lye. Erfurt subsequently varied this process by boiling the wood twice before cooking it in the caustic soda, a process which yielded wood pulp of a superior quality. The papers so produced have been gradually improved, and now packing-papers of excellent quality are thus manufactured, which can be used for a variety of purposes for which ordinary papers are more or less unsuited. For many purposes the natural brown colour of the paper is a recommendation, and not only for cartridge-cases, book-covers, packages, and the like, but also for floor-papers it is found most useful. Erfurt prepares his "lignite pulp" in four qualities, which can be used separately or combined in different proportions, for the manufacture of different qualities of paper.

2. *Preparation of cellulose by the chemical method*.—The preparation of cellulose by chemical means has recently made greater progress, as a much finer and whiter product is thus obtainable than by the mechanical method; still there is, unfortunately, one great disadvantage common to all the processes yet adopted—the expense, costly machinery and processes being employed for an object really attainable by other means. These consist in the continuous action of chemical re-agents, whereby the expenditure of fuel is rendered unnecessary, and the great wear and tear of plant involved by the use of high steam-pressure avoided.

Various companies and private firms have applied themselves to cellulose manufacture, amongst whom the most important are Wooster & Holmes, Brandt, Montgolfier, Brogniart, Morier & Legaux, Pagen, Coupier & Mellier, Compagnie, Pentagène, Arnould, Houghton, Fredet, Pelouze, Barne & Blondel, Bachet, and Watt & Burgess.

A fresh starting-point in cellulose manufacture was afforded by the establishment of the Manaehunk Wood Pulp Works Company, at Philadelphia, in 1864, whose products were exhibited in Paris, in 1867. At this establishment the cellulose is prepared by Houghton's and Coupier's methods by boiling

the wood in acetate of soda under very high pressure. This branch of manufacture has been further investigated and improved upon by various parties, amongst whom may be mentioned Delaye, 1864; Neyret, Orioli & Fredet, 1865; Bachet & Machard, 1866; Fletcher, 1868; Tessié du Motay & Maréchal, 1868; and, more recently, Adamson, Molenau & Laubuhr, Schutz, Mohl, Fry, &c.

In 1868 the Gloucestershire Paper Company started a large cellulose and paper manufactory in England, for paper-making without rags, thereby affording demonstration of the fact that paper can be manufactured from cellulose without any admixture of rags. A heavy outlay, stated to amount to £25,000, was involved by the experiments of the Company.

In 1870 a Company of English and Swedish capitalists started five large cellulose manufactories in Sweden, on the American system in use at Cane Mills, Sydney, N.B.

On this system the five manufactories in question, and other English and American establishments, are now worked, as well as six large manufactories in Germany. Some manufacturers have adopted other methods, and have engaged in fresh experiments and researches, chiefly with a view to remedy defects of construction in the apparatus employed.

In the different methods hitherto adopted acids (muriatic and nitric) are used, to the action of which the wood finely rasped is exposed until the fibre is laid bare, whereby a portion of the cellulose is converted into glucose, whence alcohol is obtained by fermentation; after this the wood is treated with acetate of soda until all the soluble matter is extracted, and finally is washed. This method does not admit of the acid being used again, and moreover requires the vessels employed to be of more than ordinarily indestructible materials.

In Watt & Burgess's method, finely-chopped wood is treated with acetate of soda of 4 degs. Réaumur, under a steam pressure of 60lbs. to 190lbs. to the square inch. Here very much depends on the shape of the wood: in a highly comminuted form, as sawdust, the circulation is impeded; shavings, on the *other hand, take up too much space; so the wood is treated* with the lye in a series of digestors, under high steam pressure, and the soda afterwards extracted from it by the action of steam. As the lye contained therein is removed by the steam, and the residuum calcined in ovens of special construction, it is obvious that the method adds considerably to the cost of the process, and it is preferable to use the acid once only and allow it afterwards to evaporate naturally in open pits or to remove it by heating in closed vessels so contrived as to entail no extra firing. Cellulose prepared in this way requires no mechanical manipulation, but is simply bleached with chloride of lime before use. Chemically prepared wood pulp is superior to that prepared by mechanical means, being more elastic and longer

in the fibre, and, as before mentioned, can be employed for paper-making without any addition of rags.

As regards yield, much, of course, depends on the character of the wood, but it averages 30 to 40 per cent. The largest yield is from split trunkwood, and young wood of 4-inch diameter. Firs yield a lighter coloured and more easily bleached pulp than pines. German manufacturers now work almost entirely with pine wood, and obtain a very fine product. To give a profit, the prices in the forest should not exceed the following:—

One metre billet wood	...	6½ marks (shillings).
One „ round ditto	...	5 „ „
One „ small sticks	...	2½ „ „

In Swedish cellulose manufactories the following is the mode of procedure:—The wood, stripped of the bark, and machine-sawn into small bits about half an inch square and quarter inch in thickness, is passed through a separator, so as to secure as much uniformity of size as possible. It is then put in a perforated bleaching vessel, which, after it has been filled, is screwed into a horizontal boiler filled full of soda lye, and made to boil by direct firing. When, after many hours' cooking, the lye has attained a certain temperature, corresponding with a pressure of about 10 atmospheres, the boiling is ended, and after remaining some length of time under pressure, the lye is run off, leaving the remains of the wood in the shape of bare cellular fibre. The cellulose thus obtained is deprived of the brownish fluid it contains by beating and washing in vats, and lastly is passed through sieves to get rid of the sand, and pressed into sheets, in which form it is sent to the paper-mills, either in the wet state, containing 50 per cent. of water, or air-dried. The liquor flows into a large receiver heated by the waste heat of the chimney, and thence into an elongated stove, where it is brought to the consistency of pitch, by which means all the organic matters in it are destroyed. The carbonate of soda is then rendered caustic by the addition of lime, and can be used over again. From 80 to 90 *per cent. of the soda is* thus recovered.

In the establishment of a cellulose manufactory both the site and the water-supply have to be considered, so that the raw material, water, and cheap fuel may all be at hand. Existing arrangements are, however, susceptible of much improvement.

A method lately introduced in practice by Professor Mitscherlick, of Minden, Hanover, here merits special notice, as beyond all others it gives promise of an important future.

This method consists in treating the wood, in a less comminuted form, with a double calcic sulphite, obtained by a special process equally applicable to the preparation of other sulphites. Lime, in the form of carbonate, is decomposed in apparatus of

special construction with the aid of sulphurous acid, obtained by the combustion of sulphur or certain sulphides. The action of these double calcic sulphite solutions on the comminuted wood or other plant substance separates the cellular fibre from the other matters by which it is held together. Cellulose is thus obtained in the condition in which it exists in the plant itself. Washing readily separates any soluble matters, and the cellulose is then ready for the paper-maker. These soluble matters embrace a variety of substances, differing with the plant and the portions of it employed. Among the materials thus obtainable the following may be specially mentioned:—(1), tan-stuffs, for the tanning of hides and skins; (2), gums; (3), vinegar; (4), alcohol.

The liquor, of course, requires various kinds of treatment, according to the special object in view. Where this is the preparation of cellulose alone the method presents many advantages over those at present in vogue. The use of acetate of soda, for instance, destroys much of the cellulose, deteriorating its strength, imparting to it a brown hue, and reducing the yield. Cellulose prepared with the double calcic sulphite solution possesses great length and strength of fibre, and is as white as in the original plant. Bleaching with chlorine or chloride of lime is especially to be avoided, as even in cases where the effects are not apparent the strength of the fibre suffers thereby. In this particular the method of bleaching cellulose introduced by J. Erfurt offers a great improvement. The fibre is freed from pectin by treating with alkalies at a high temperature before the calcic chloride bleaching solution is applied *in vacuo*. The air is thus completely abstracted from the cavities of the plant-cells, and the bleaching process is rendered much more expeditious and complete.

According to data given by the Civil Engineer, C. Rosenhain, a cellulose manufactory, using steam-power, and working night and day, with an annual production of 20,000 centners,* will consume the following materials in a year:—(1), calcined soda, 3,000 centners; (2), burned lime, 14,000 to 18,000 centners; (3), wood, 20,000 cubic metres; (4), coal, 175,000 centners.

A factory of this size covers an area of about 18,000 square metres (200,000 square feet), and employs sixty to eighty hands.

With a less production than 10,000 to 15,000 centners of cellulose, a manufactory cannot be worked at a profit. It must have one boiler, whereas a factory with double the annual production only requires two boilers. The consumption of water in the former case will be 60 to 70 cubic feet per minute. In the production of the 7,000,000 centners of paper manu-

* The German centner is 110 lbs. Avoirdupois.

factured in Austria and Germany in the year 1877, there were used :—Wood fibre, 2,000,000 centners; wood cellulose, 100,000 centners; straw cellulose, 600,000 centners; rags, 5,500,000 centners.

Besides for paper-making, the following technical applications of cellulose may be mentioned :—The manufacture of artificial ivory, by Harrass's patent, the preparation of explosives, for blasting. Cellulose, wood fibre, and fine sawdust are used in the preparation of various substitutes for nitro-glycerine, such as Dittmar of Charlottenberg's dualine, Volkmann's collodine, Franzel's nitro-glycerine, Baron Tintschler-Falkenstein's ligrose, and the patent dynamite of the Hamburg Dynamite Co.

For upholstering, wood fibre is now largely used as a cheap and cleanly substitute for horse-hair and other stuffing for mattresses, cushions, &c. Plane, fir, and beech fibres are mostly used for this purpose. The use of cellulose or sawdust, in the manufacture of oxalic acid, dates from a discovery made by Guy-Lussac in 1829, but received its first application in practice at the hands of an American firm, Roleits, Dale & Co., of Washington, in 1859.—*Timber Trades' Journal.*

Ceara Rubber.—"*Germinating the Seeds.*—File each seed carefully on both sides, until the kernel is just visible. The two ends may be rounded off a little, but the operation requires care. When the filing is finished, have ready a solution of kerosine oil and water (one to ten), and immerse the seeds in it for a second or two. This prevents ants and other insects from coming near them. This operation over, the seeds should be thrown into a tin box containing some coir fibre refuse; cover them well over with a further supply of the same material and shut down the box. In two days' time they will be found on examination to have commenced to germinate. Take them out and put them (germ downwards) into Wilton's transplanters filled with good soil, on a table, with its legs in saucers of water. Three or four days more will suffice to let the seedlings develop into nice, healthy, little plants, and ten days from the date of the commencement of the operation they can be finally transplanted. When the seeds are in the box of coir refuse no water is required, and even when put into the transplanters very little moisture is needed.

"The young plants are remarkably strong and love the sun. They are, however, very impatient of moisture, and should therefore be placed under cover during a shower of rain. The filing operation may be done on a grind-stone; but to ensure perfect success each seed should be rasped carefully with a file.

"Some planters lose as many as 60 and 70 per cent., and in one instance, which has come to my knowledge, five plants

only were secured out of 300 seeds. I am indebted to a gentleman in Colombo for the above simple but effective way of germinating the seed, and can confidently recommend its general adoption. Not a single seed need be lost if the directions are carefully followed.

"*Planting out.*—It being important that the Ceara species of rubber should be induced to grow cocoanut-fashion with a tall, clean stem, it will be found necessary to plant them pretty close to each other, say 500 to the acre; and so far as my experience goes, plants grown from seed are more likely to develop into this style of tree than those propagated by cuttings. The latter grow faster, perhaps, and blossom earlier—a matter of some importance in cases where a supply of seed is required; but for a permanent plantation I am of opinion that every tree should be raised from seed."—*Tropical Agriculturist.*

THE PAPER MULBERRY TREE.—(*Journal of the Society of Arts, 2nd September* 1881).—The United States Minister of Agriculture, in a recent report, calls attention to the largely increasing manufacture of cloth in China, Japan and the Sandwich Islands from the paper mulberry (*Broussonetia papyrifera.*) In Tahiti and other South Pacific Islands a species of cloth is manufactured from its bark, known as "Tappa" or "Kappa," and it is said that the finest and whitest cloth and mantles worn by the islanders and the principal people of Otaheite are made from the bark of this tree; it dyes readily, particularly in red, and takes a good colour. The following is the method employed by the native women of Otaheite in beating out the fibre: The cleansed fibres are spread out on plantain leaves to the length of about eleven or twelve yards, and these are placed on a regular and even surface of about a foot in breadth. Two or three layers are thus placed, one upon another, great attention being paid to making the cloth of uniform thickness; if thinner in one place than another, a thicker piece is laid over this place when the next layer is laid down. The cloth is left to dry during the night, and a part of the moisture having evaporated, the several layers are found to adhere together, so that the whole mass may be lifted from the ground in one piece. It is then laid on a long smooth plank of wood prepared for the purpose, and beaten with a wooden instrument about a foot long and three inches square. Each of the four sides has longitudinal grooves of different degrees of fineness, the depth and width of those on one side being sufficient to receive a small pack thread, the other sides being finer in a regular graduation, so that the grooves of the last would scarcely admit anything coarser than sewing silk. A long handle is attached and the cloth is first beaten with its coarsest side and spreads very fast under the strokes. It is then

beaten with the other sides successively, and is then considered fit for use. Sometimes, however, it is made still thinner by beating it after it has been several times doubled with the finest side of the mallet, and it can thus be attenuated until it becomes as fine as muslin. Should the cloth break under this process, it is easily repaired by laying on a piece of bark, which is made to adhere by means of a glutinous substance made from the arrowroot, and this is done with such nicety that the break can scarcely be detected. In other islands the bark is kept wet and scraped with sharp-edged shells. It is said that the king of the Friendly Islands had a piece made which was 120 feet wide and two miles long. In Japan a species of cloth is made from paper derived from this tree. It is cut into thin strips, which are twisted together and spooled to be used in the woof of the fabric, while the warp is composed of silk or hemp. About 250 pieces only are manufactured at the principal manufacturing place. The paper mulberry grows everywhere in Japan, and is a valuable tree, as furnishing the bast from which a large portion of the Japanese paper is made; the plants are reproduced in quantity by sub-dividing the roots, and in two or three years are ready to be cut. This work is done in November, and the branches, from seven to ten feet long, are made up into bundles, three or four feet in length, and steamed so that the bark is loosened and can be more readily stripped off; this is washed, dried and again soaked in water, and scraped with a knife to remove the outer skin which is used for inferior kinds of paper. The bast when cleaned, is washed repeatedly in clean water and rinsed; it is then bleached in the sun till sufficiently white, after it is boiled in a lye, chiefly of buck wheat ashes, to remove all gummy matters. The fibres are now readily separated, and are transformed into pulp by beating with wooden mallets; the pulp is mixed in vats with the necessary quantity of water, to which is added a milky substance prepared from rice flour. The couches on which the paper sheets are produced are made of bamboo, split into very thin sticks, and in parallel lines by silk or hemp threads, so as to form a kind of mat. This is laid upon a wooden frame, and the apparatus dipped into the vat, raised and shaken, so as to spread the pulp evenly, after which the cover is first removed, then the bamboo couch with the sheet of paper. When a number of sheets have been thus prepared, they are pressed to exclude the water, and afterwards spread out with a brush upon boards and allowed to dry. The sheets are only about two feet in length, but sometimes sheets ten feet long are produced.—*Tropical Agriculturist.*

THE TIMBER OF BRITISH COLUMBIA.—That section of British Columbia west of the Cascades, and including Vancouver and Queen Charlotte Islands is, according to Professor Macoun,

covered with, probably, one of the finest forests in the world. Chief amongst the trees is the Douglas Fir (*Abies Douglasii*), which is the chief forest tree, and which is used throughout the country for building purposes, and for export in the form of deals and spars.

White Cedar (*Thuja gigantea*) is another giant, and in the valley of the Fraser and up the coast attains to an immense size. The Indians use this wood altogether in the construction of their houses, and in building those large canoes which are the wonder of the eastern people.

The other trees are a species of Yew, another of Alder, two species of Fir (*Abies Menziesii* and *grandis*); two species of Pine (*Pinus contorta* and *monticola*); two species of Maple (*Acer macrophyllum* and *circinatum*); Hemlock Spruce (*Abies Mertensiana*, is a common tree on the mainland; while a species of Oak (*Quercus garryana*) is abundant on the island, but has not been detected on the continent. An evergreen tree (*Arbutus Menziesii*) is quite common along the coast of the island, and, both summer and winter, its foliage contrasts finely with that of the sombre-hued Douglas Fir.

In the second, or arid district, a Pine (*Pinus ponderosa*) takes the place of the Douglas Fir on the coast, and is a very valuable tree, growing to a large size, with clean trunk, and resembling the red Pine of Ontario very much. The tops of the lower mountains and the sides of the higher ones support a heavy growth of Douglas Fir, but it is far from being the beautiful tree of the coast.

The timber of the third region is not so good, and consists principally of Poplar and black Pine (*Pinus contorta*), with occasional groves of Douglas Fir on the higher hills. Black and white Spruce, with a little Balsam Fir, make up the remainder.

The island of Vancouver is about 300 miles in length, with an average breadth of about 60, and probably contains 20,000 square miles. The soil is good, but the surface is so much broken by rock that it is altogether impossible to tell the amount of good arable land on the island. There is no doubt the day will come when Vancouver will support a large population—partly agricultural and partly engaged in mining, lumbering, and fishing.

Burrard Inlet is situated on the Gulf of Georgia, a few miles from New Westminster. It is nine miles long—deep and safe. It is the port from which the lumber trade is chiefly carried on. It is very easy of access to vessels of any size or class, and convenient depth of water for anchorage may be found in almost every part of it.—*Timber Trades' Journal.*

ARGENTINE WOODS.—The British Consul-General at Buenos Ayres, in his report to the English Government, relates some

important facts respecting the valuable forests in the Argentine Republic. Of the larger varieties of timber, he says, coming from the upper provinces, the Cedar, red Quebracho, Urunday, Lapacho, Laurel, and Missiones Pines are the best known. The Cedar, which grows chiefly in the mountain slopes of Tucuman, is so similar to Mahogany that a cabinet may be made of the two mixed. As there are great forests of this timber, there is likely in time to be a considerable export when the timber trade and floating of timber becomes more systematized.

Higher up, in the unsettled districts of the Upper Parana and Uruguay, there are vast quantities of a tree of a great size—the Missiones Pine, an Araucaria; the timber is good, but is as yet very little used in the lower part of the river. The Laurel is much used for boat-building, interiors, cabinet-making, &c. There are many varieties of this Laurel, the wood of which differs in colour, though generally dark yellow with black veins, dark or light brown with green or yellow veins, &c. In the mountains of the north there are trees 400 or 500 years old of this timber, with trunks more than three yards in diameter.

Of the hard woods, the Urunday is valuable for many uses. There are many varieties; the timber is darkish, and has generally white or yellow veins and spots. Urunday timber of very great length is not often seen in trade, on account of the difficulty of transporting the larger trees. The bark, though inferior to that of many other trees for the purpose, is sometimes used for tanning. The timber is very indestructible, and is used for cart-axles, piers, house-rafters, and, indeed, for every sort of use which requires durability and strength. Railway sleepers of this wood should be practically indestructible, if selected of the proper quality.

The red Quebracho is a still heavier timber. This tree, which takes about a century to arrive at its maturity, when its average height is from 27 to 34 yards, is one of the most common in the warmer parts of the country, especially in the Chaco. This wood is, if possible, less destructible than the Urunday, and is used for house-building, piers, and also for railway sleepers. Though this wood be hard and difficult to work, there is some little tendency in the rivet-holes of sleepers made of it to enlarge by vibration in the sense of the grain of the wood when those rivets are sharp; but, using rounded bolts, Quebracho sleepers should last as well as iron.

The Lapacho, a fine tree of the family of the Bignoniaceæ, is also found everywhere in the upper provinces. It attains a greater height than the Urunday and red Quebracho, its wood is lighter in colour with a greenish tinge, and is very durable. It is much used for building and other purposes. The Viraru affords an oak-like timber, and is in many respects very like the Lapacho, though it does not grow to the same size. These

are the most important trees, but there are innumerable other kinds of valuable woods produced in smaller quantities of which a very long list could be made. It is only to be trusted that their total destruction by unauthorized squatters and others will not have taken place before improved communications with the rich forests make them more available for general use.—*Ibid.*

We have received the following letter regarding the gnawing off of branches of the Oleander tree. We cannot, in camp and away from books, verify an opinion, but we think the enemy must be either a large beetle, such as we have heard of as cutting off twigs with their mandibles, or a squirrel. The appearance of the specimen seems to point to some rodent animal having done the mischief. But then the wood of the Oleander, as is well known, is poisonous. Perhaps some of our subscribers can explain the difficulty :—

Dear Sir,—Will any of your correspondents explain the following curious phenomenon. In a friend's garden are two Oleander bushes. Some animal or insect unknown girdles the branches of these bushes. It is evidently not for the sake of the bark, for then patches would be eaten. Neat rings are gnawed round the branch, in some cases merely through the bark, in others the wood is also gnawed until the branch breaks. The only solution seems to be that the operator unknown wishes to kill the branches. But then what is this operator? And why does he want to kill the branch?

I send you three specimens ; in two cases merely the bark is gnawed ; in the third the whole branch is gnawed through. These Oleander are in the middle of a number of shrubs of various sorts, but none but the Oleander is touched.—Ghati.

Readers of the Indian Forester will be glad to hear that M. Demontzey has just brought out the long-promised popular edition of his "Manual of Reboisement Works." The original edition was exhausted very soon after its appearance in 1878, and those not fortunate enough to get a copy from the French Government, or from the author himself, found it impossible to study the wonderful system so patiently elaborated by the author and others. Even at Barcelonnette, in the centre of numerous complete and progressive reboisements, the want of an explanatory manual was much felt by every visitor anxious to learn all the plans and methods which had been devised.

At last, in answer to the repeated calls for a new edition, the author has given us a most complete work, founded on the original, but yet so much revised and altered, as to be almost a new work. Much extraneous matter has been omitted, and its place taken by full information of the latest advances made

in reboisement. The woodcuts and plans are now printed with the text, a great improvement, and the book itself is printed in a handier form than before.

It cannot fail, we think, to be of great use to many persons in India, who are interested in the replanting of denuded areas and in the prevention and cure of destructive torrents.

At the same time, M. deGayffier is bringing out, under the title of "Iconographie du Reboisement des Montagnes," a series of fifty plates, illustrating the various French Reboisements in the Alps and the Pyrenees. The plates are selected from the large series of photographs, exhibited by M. deGayffier at the Paris Exhibition of 1878, which attracted much attention at the time. Descriptive letterpress accompanies the plates, but as they are meant to be studied with M. Demontzey's Manual, each author gives the necessary references to the other's work. M. deGayffier's work is also published by Rothschild, and is to appear in ten parts, costing sixteen francs each. It is much to be regretted that the price is so high as to be almost prohibitive. M. Demontzey remarks in his preface that the two publications together will furnish the most complete means for studying the universal question of how to restore denuded forest areas; and having regard to the importance of the subject for India, we venture to think that, if Government bought a copy of M. Gayffier's plates for each province, many persons would avail themselves of the opportunity of studying them and of gaining very valuable information.

Few Forest Officers have an opportunity of visiting the works in France; and we can speak from our own experience of the immense advantages to be derived from plates and photographs so accurate as these. Until one has visited the Basses Alpes, one can form little idea of the destructive nature of the torrents and often difficulties of soil, climate, &c., which have been successfully overcome; but carefully selected views, such as those now being published, give one most valuable information as to when and where the different plans detailed by M. Demontzey should be applied. —V.

PILING WOOD.—A correspondent writes to the *Detroit Post*:—"I have sold wood for over forty years in Michigan, and I find that when split wood is corded up the bark remains on until I sell and measure up the wood, and all that is piled bark down the bark falls off and measures nothing; besides, there is more heat in the bark than in the sap of the log. The most and best ashes are also in the bark. I have on my place now some maplewood that was chopped nine years ago, and corded bark up, and the bark would hold on if I would draw the wood to Saginaw (eighteen miles), and cord up and

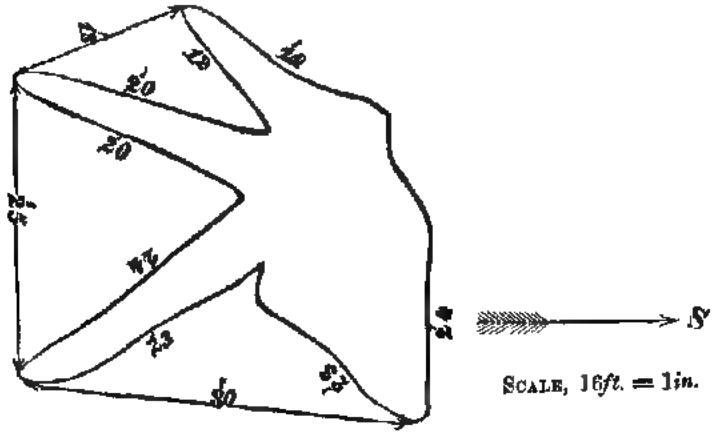
measure; besides, the bark is lighter to draw. Where the bark is piled down the water runs in around the wood and makes it dozy, wet, and heavy. Tell your neighbours to try it. Railroad companies would save thousands of dollars by piling their wood bark up."—*Timber Trades' Journal.*

FIREPROOF WOOD.—P. Folbarry, of New York, says the *Lumberman's Gazette* has devised a method of making wood incombustible without in any way altering its outward appearance. Wood prepared in accordance with his process may possibly be charred just at the surface, but the heat to which it is exposed, though ever intense, can never penetrate righs into the wood and touch its fibres. Timber petrified in this way is particularly suitable for staircases that are to resist a conflagration. The composition devised by the inventor is as follows: 55 pounds of sulphate of zinc, 22 pounds of potash, 44 pounds of alum, 22 pounds of sesquioxide of manganese, 22 pounds of sulphuric acid at 608, and 45 pounds of water. The whole of the solid substances are put in an iron vessel, containing the water at a temperature of 113° F. When all this solid matter is dissolved, the sulphuric acid is poured in slowly until the whole is saturated with it. The solution is now ready, and in order to prepare timber with it the pieces must be put on an iron grate in a suitable recipient, in accordance with the size of the pieces and the object for which they are intended, care being taken to leave half an inch between any two pieces. The composition is pumped into the recipient, and after the whole of the spaces have been filled up it is left there in a boiling state for about three hours. The wood is then taken out and placed on a grate-like wooden stand in the open air, to make it dry and firm. When thus prepared, the impregnated wood may be used for building in general, wooden pavements, and all purposes.—*Timber Trades' Journal.*

CAN any of our readers give us any information regarding the weight and cubic contents of minor produce? We have recently had occasion to weigh some Hurra (Hirda) fruits and find that stacked dry fruits give two cubic feet to the maund as nearly as possible.

Some factor of conversion is also wanted for bamboos. The common male bamboo is very heavy; indeed the butt end of a green halm will not float. We found that a bamboo halm cut into three lengths of 11 feet each, the three being tied together, just floated, though of course it could do so better when dry. As far as we have been able to calculate, we find that 100 male bamboos, averaging 11 feet long, give about 12 cubic feet of solid wood and 34 cubic feet of stacked wood. But we should be glad to hear if any of our readers have any more exact experience to record.

LARGE COTTON TREE IN PALAMOW.—Readers of Mr. Ball's "Jungle Life in India" may have noticed a description at page 652 of a large silk-cotton tree at Seraidih in Palamow, regarding which he says: "At Seraidih there is a silk-cotton tree *(Bombax malabaricum)* which I believe to be the largest tree I have ever seen; unfortunately I do not retain the measurements of this vegetable monster. I did not realize its enormous dimensions until I saw the pack-cattle and elephants stalled between the huge flange-like buttresses which project from the main stem. I think I estimated by shadow-measurement the height to be 140 feet." We recently had an opportunity of inspecting the tree, and can certainly bear out Mr. Ball's statement as to its appearance from a little distance giving very little idea of its real size. We now give a roughly prepared ground plan of the tree and its buttresses which may prove interesting.



The girth round buttresses was 115 feet. The height was, as nearly as we could ascertain, 135 feet, though the calculation made, as Mr. Ball made it, by the shadow, gives much more. But as the tree has a very rounded head, and the sun was rather low at the time, it is not surprising that the height could not be satisfactorily estimated by that method.

The tree stands alone in the middle of rice-fields, and has its buttressed side to the north. Seraidih is a large village lying half-way between the Kechki and Betlah Forest Reserves and in the angle formed by the junction of the rivers Koel and Aurunga. It is about three miles from the junction of those rivers, and about five from the curious old forts of Palamow.

THE SUNKEN FORESTS OF NEW JERSEY.—The following is a description of these sunken forests taken from the *Northwestern Lumberman*:—

Dennisville, four miles south of Woodbine, the latter on the West Jersey railway, is a sprawling, dingy township of 3,000 inhabitants, with its central group of houses on a causeway between two great swamps. The wet lands around are covered partly by solid growths of white cedar, partly by thick water weeds, and partly by stumps and fallen logs of immense size. These are only the surface indications of the wealth below. The swamps, covering ten square miles, are underlaid with sunken forests, which grew hundreds, and perhaps thousands of years ago. The seeming worse than barren waste, for which the sharpest of Yankee farmers would deem fifty cents an acre a swindling price, have been worth by the acre their hundreds of dollars. They have turned their own desolation into a hive of industry, built up a lively village, and made an addition, as legitimate as it is unique, to the wealth of the country.

The huge trees which lie under the swamp to unknown depths are of the white cedar variety, an evergreen, known scientifically as the *Cupressus thyoides*. They grew years ago in the fresh water, which is necessary for their sustenance, and when, in time, either by a subsidence of the land or a rise of the seas, the salt water reached them, they died in great numbers. But many of them, ere they died, fell over as living trees, and were covered slowly by the deposits of muck and peat which fill the swamp. These trees that fell over by the roots are known as windfalls to distinguish them from the breakdowns. The trees which broke off are the ones most sought for commercial uses, and they are found and worked as follows: The log-digger enters the swamp with a sharpened iron rod. He probes in the soft soil until he strikes a tree, probably two or three feet below the surface. In a few minutes he finds the length of the trunk, how much still remains firm wood, and at what place the first knots, which will stop the straight split necessary for shingles, begin. Still using his prod like the divining-rod of a magician he manages to secure a chip, and by the smell knows whether the tree is a windfall or breakdown. Then he inserts in the mud a saw, like that used by ice-cutters, and saws through the roots and muck until the log is reached. The top and roots are thus sawn off, a ditch dug over the tree, the trunk loosened, and soon the great stick, sometimes five or six feet thick, rises and floats on the water, which quickly fills the ditch almost to the surface. The log is next sawn into lengths two feet long, which are split by hand and worked into shingles, as well as into the staves used for pails and tubs. The wood has a coarse grain, and splits straight as an arrow. The shingles made from it last from sixty to

seventy years, are eagerly sought for by builders in southern New Jersey, and command in the market a much higher price than the ordinary shingles made of pine or chestnut. In colour the wood of the white cedar is a delicate pink, and it has a strong flavour, resembling that of the red cedar used in making lead pencils. The trees once fairly buried under the swamp never become water-logged, as shown by their floating in the ditches as soon as they are prized up, and, what is more singular, as soon as they rise they turn invariably underside uppermost. These two facts are mysteries which science has thus far left so. The men who dig the logs up and split them earn their money. The work is hard, exacting, requiring lusty manual labour, skill, and experience.

Owing to the fact that the swamps are soft and treacherous, no machinery can be used, and long stretches of mud and water must be covered with boughs and bark before the shingles can reach the village and civilization. The number of the trees which lie below the surface of the ten square miles of swamp is almost countless. In many places the probe will be sunk many times before it fails to strike a log. As the workmen only dig for those near the surface, and none but the best trees are selected, it is certain that only a small fraction of the logs have been exhumed since 1812, when the industry first sprang up. The sunken forests lie in all shapes. Sometimes the trees are found parallel, as though a wind blowing from one quarter had felled them, but usually they lie pointing in every direction, and when, as occasionally happens, the wet soil sinks or dries, the mighty trunks are seen piled upon each other as in a Maine log jam. What are seen to-day are but the uppermost strata of piles upon piles unseen below.—*Timber Trades' Journal.*

Brazilian Timber.—Within an area of half a square mile Agassiz counted 117 different kinds of wood, many of them admirably fitted by their hardness, tints, and beautiful grain for the finest cabinet work. The *muirapinima*, or tortoiseshell wood, undoubtedly the most precious wood in the world, is found in large quantities on the tributaries of the Amazon, where the water can be easily used as a motive-power. Many varieties of beautiful woods, easy rivals of the finest black walnut, are wasted yearly on the Amazon in amounts sufficient to veneer all the palaces of Europe. Maurice Mauris, the explorer, believes that with the facilities with which the Brazilian Government is ready to impart to enterprising industry the export of these commodities would yield enormous profits in a short time, while the amount of capital engaged need not be great. It is only necessary that these woods be introduced into the market to obtain a decided preference over those now most sought after in the two hemispheres. Still

richer is the country in timber for constructive purposes. The acapu (*Vauacapoua Americana*) is most plentifully found there, and often in the most imposing proportions. Mr. Mauris has seen dining-tables six feet in width, made wholly out of one piece. This wood, like all its kindred macaranduba and itauba, or stonewood, furnishes ship-timber as durable as teak. The longer these remain in water the stronger and harder they become.—*Toronto Industrial World and ibid.*

French Walnut.—An American gentleman who has visited the principal cabinet-wood markets of Europe says that the finer quality of French walnut is growing scarcer each year, and that it will soon be difficult to obtain a sufficient supply. The supply this year is quite small, and wood of choice quality comparatively rare, but through being personally on the ground, and using much care in selection, he was able to purchase a stock of about 200 burrs and 150,000 sheets of veneer, which are far above this year's average and of quite exceptional quality. Prices are very firm, and at present French walnut commands a price as great, or greater, in Paris than in New York. He says that the business of importing French walnut burrs from Circassia, where they grow, is almost entirely in the hands of a few Parisian firms, which reserve most of the choicest burrs for cutting into veneers for domestic use, so that it is a matter of some difficulty for outsiders to procure the best wood unless they buy it in the shape of cut veneers.—*American Furniture Gazette, and ibid.*

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The Teaching of Forestry.

By Colonel G. F. Pearson.

A LECTURE DELIVERED, MARCH 1st, 1882, BEFORE THE SOCIETY OF ARTS.

PART I.

In presenting myself before you this evening, I would solicit your indulgence in my endeavour to offer to your notice a few facts about forestry—a science which is daily attracting more and more attention in all the countries of Europe, as well as in the colonies of Great Britain, and in the United States of America. This is, no doubt, owing in part to the depressed condition of agriculture during the last few years in Europe; but it is due also largely to the increased demand for timber which the advance of civilisation brings with it. For where in some industries, as in ship-building, iron has largely taken the place of wood, in numberless others, as in railway works, the drain on the forests has enormously increased. I trust that, without entering into any complex questions of sylviculture, which, however interesting in themselves, would be too long to discuss here, I may be able to place before you a few facts which may be worthy of your attention. I will first endeavour to give you a short sketch of the rise and progress of scientific forestry in European countries, and afterwards very briefly to explain the principles on which it is based.

Sylviculture, or the culture of forests, as it is understood and applied in the countries of Europe, where it has been studied as a science, is the application to woodland property of certain economical principles, which, in their spirit, contain nothing more than what is held to be necessary for the well-ordered management of landed property in general; and which may be summed up as follows:—

1*st*.—The obtaining, within approximate limits, of a regular sustained revenue from the land which the forest covers.

2*nd*.—The utilisation, to the fullest extent possible, of the natural productive powers of the soil.

3rd.—Progressive improvement in the value of the property.
4th.—Final realisation of the crop to the greatest advantage.

It is in the development of these principles, and in their application to forests of different sorts, that the true science of forestry consists.

Now, for various reasons, but chiefly on account of the abundance of coal in Great Britain, and the facilities of obtaining, at cheap rates, all sorts of timber from other countries, which our commerce affords, the management of forests has not as yet attracted so much attention among ourselves as it has done elsewhere; and even where, as in Scotland, considerable natural forests existed in times past, since railways have penetrated into distant parts of the country, they have too often been cut down, and their value realised; and in consequence, natural mature forests of any great extent do not at present exist in Great Britain; and, though there are a fair amount of plantations in various stages of growth, and some of them of considerable extent and in excellent order, their treatment has, up to the present time, been confined to simple cultural operations, and their management as forest property has been but little thought of. To this may be added the fact, that all the great forest properties in Scotland, and most of those in England, belong to private owners, whose interests will not always allow of their working their forests, for results which can only be properly developed after a long series of years. These and other similar reasons have, up to the present date, stood in the way of the growth among us of any sound system of managing our forests; but there can be no doubt that the subject is now beginning to attract a far larger amount of attention than it has ever yet done before.

Before going any further, it may be interesting to sketch briefly the history of the rise and progress of forest science on the Continent of Europe.

During the early periods of civilisation which succeeded the Roman occupation of Gaul and Great Britain, the forests, both in our own country and on the Continent, covered vast areas of country, and it was one long-continued struggle of the population against their growth, which was then equally an enemy to pasturage and cultivation; often, too, where border feuds and wars were of constant occurrence—as in Scotland between the different clans, and also between the lowlands and the border counties of England—the forests were burned and destroyed by the conquerors, in order that they might not be used as a refuge by the other party, or as a shelter for making reprisals. The timber, as such, had then no value whatever. Later on, while the population was still sparse, and roads and other means of communication were few and difficult, timber had but little value, except near the large towns, and at this time the forests were objects of interest only to the princes and

nobles, who used them as their hunting grounds, and who carefully preserved them from encroachment as long as their interests in this particular were not interfered with—but not otherwise, for it was at this period that those common rights sprang into existence, which, arising out of compromises between the population and the nobility, have in later times proved such a fertile source of trouble to forest conservators both in England and on the Continent.

It was about the beginning of the seventeenth century that the then rapid disappearance of the forests seems to have first attracted attention in the different countries of Europe; and among the first traces of attempts at forest management, certain regulations may be quoted, which were made so far back as the reign of Elizabeth, to regulate the number of standard trees in the oak-coppiced forests belonging to the Crown. In France, the *Ordonnance* of 1669, issued at the instance of the great minister Colbert, had a similar object. These regulations, however, were simple measures of police, restricting the felling of certain trees, under certain conditions, and they contained no scientific principle whatever; while the agents employed to carry them into execution were probably persons of the lowest class, living in the immediate neighbourhood of the forest, and consequently too often ignorant, dishonest, and interested, as the long list of fines and punishments inflicted on them for frauds and embezzlements, which still exist, seem to indicate. It is very doubtful if the forests even benefited at all from their care. Nevertheless, the subject was not entirely lost sight of in France, as the studies of Duhamel de Monceau, Linné, Bernard de Jussieu, Buffon, and Cuvier go to prove. Later on, attempts were made to work on what we should call, now, a regular system, by fixing a certain period, called a revolution, in which the forest was destined to be cleared off entirely, and reproduced by natural seeding; and to this end it was divided into a number of compartments equal to the number of years in the revolution, one of which was felled every year, or at such regular intervals of time as was determined in the working plan, a few standard trees only being left as seed-bearers. This system was known in France as that of *tire et aire*, and continued in operation till within the last half century. But this, as is now well known, will not suffice to ensure the regular natural reproduction of a forest, and, in consequence, it often happened that those so operated on were either ruined entirely, or were changed altogether in their character. Indeed, any approach to sound forestry was unknown in France till the forest school was established at Nancy in 1824.

Previous, however, to this date, and, indeed, before the close of the last century, considerable progress had been made in the right direction by the German foresters on the other side

of the Rhine, who were undoubtedly the first to base the principles of forestry on observation, and to treat it in a scientific manner—Hartig (1762-1837), Cotta (1763-1844), Hundeshagen (1783-1844), were the founders of that system of working forests by thinning at regular intervals, first, for the improvement of the crop, and afterwards for its realisation, which has since been developed into a regular science in the forest schools of Germany and France. Hartig founded the school of Dillenberg, in Nassau, where, in the year 1800, he had at least 70 pupils. Cotta founded that of Tharandt, in Saxony, which in the year 1812, numbered upwards of 100. These schools seem to have disappeared about the year 1820, and were replaced by others in all the German States, *viz.*, at Elberswalde, in Prussia (founded in 1867), Tharandt, in Saxony (founded on the old establishment of Cotta, soon after 1820); Münden, in Hanover; Giessen, in Hesse; Aschaffenburg, in Bavaria; Tubingen, in Wurtemberg; Eisenach, in Coburg. It was not till the year 1824 that any step was taken in the same direction in France, when the Nancy School was founded, with Lorenz as its first director. The *Code Forestier* was published in France in 1827, but it was not till 1837 that the first edition of a work on forestry appeared there, in the shape of the Lectures of Lorenz, edited and published by his successor, Parade, at the Nancy School. Since then, however, the works in France has been vigorously developed, and the Nancy School has taken a high place among the schools of Europe, chiefly owing to the long and happily uninterrupted labours there of Monsieur Nanquette, the late director, the late Professor Bagneris, who for 22 years was Professor of Forestry at the school, and Professor Broillard, now Conservator of Forests at Macon, whose teaching, and whose works on forest management, have done more, perhaps, than anything else to clear the subject of forestry in France from empiricism, and to place it on a thoroughly practical foundation. Nor have the Germans, who first led the way, remained behind their French colleagues, as any one who will take the trouble to visit their admirably managed forests must allow. Nowhere can the practical results of the natural system be seen better than in some of the German forests, where it has been in operation in some places for at least a century.

Besides the establishments for teaching forest management in Germany and France, schools of sylviculture now exist in all the principal countries of Europe, except in Great Britain, Austria, Italy, Russia, Switzerland, and even Roumania, most of them, after sending pupils for a few years to the French and German schools, have set up schools of their own, and thus rendered themselves independent of foreign educational aid. The United States of America, only last year, sent an able and distinguished man (Dr. Hough) to visit all the forest

schools in Europe, with a view of founding one in America; and it is no doubt to be regretted that, as yet, no steps have been taken to do the same in Great Britain; for with us, as elsewhere, a forest school would become, not only an establishment for teaching sylviculture, but also a centre of study and practical observation, from whence a knowledge of sylviculture, as a science, would be spread abroad, for the benefit of society in general.

It is certain that unless the forests of a country are properly and economically managed, the time may come, when, as was the case in India, it will find itself without the means of procuring the needful supply of timber, except at an extravagant price; while, at the same time, the general interests of the community require that a fairly abundant and cheap supply should be constantly available. This is especially the case where, as in the great continental areas, deficiency in the means of transport, or the distance from the timber-producing tracts, adds materially to its cost. In such cases experience has shown that the only practicable way out of the difficulty is for the State to intervene; and, although in England we have special facilities for supplying our wants from abroad, owing to our extended commerce with all countries, the extreme limits of a reasonably cheap supply seem to have been reached; and at all events State action seems so far desirable as to help private proprietors to make the best use of their timber-producing lands.

In India considerable progress has already been made in the right direction; for there the question forced itself into notice more than a quarter of a century ago, and the first steps for forming a regular forest administration there were taken immediately after the mutiny. Dr. Brandis was appointed Inspector-General of Forests in 1863, and in 1867 his scheme for training foresters for India in the schools of France and Germany was, after much discussion, adopted finally by both the Home and Indian Governments. Indeed, as a matter of fact, at home there were neither foresters who could teach the science of sylviculture, nor schools in which it could be taught. It is not too much to say that, in spite of the drawbacks inherent in such a system, the result has amply justified Dr. Brandis's expectations, for the foreign schools have given the State a body of able men, thoroughly grounded in the management of natural forests covering extensive tracts of country, as they do in India. But meanwhile, nothing has been effected for the advancement of forest science at home; and this is, in consequence, the weak point in an otherwise admirable system. The practical disadvantage of this is now beginning to make itself felt in regard to our Colonies, where forest management is now manifesting itself as the great economic question of the day. Within the last two years both the Cape of Good Hope

and Cyprus have been furnished with forest officers from France, owing to the absence of any available educated men in our own country. The Mauritius, Ceylon, the Straits Settlement, Hongkong, Fiji, and other Colonies, are all following suit, and have recourse to Kew and other similar institutions for foresters. But these institutions are incapable of supplying their wants, for the creation of plantations is a very different study from the management of forests which already exist in a natural state.

Now, the cause of the present difficulty is not far to seek. It is that there lacks with us anything like a central establishment at the head-quarters of the Empire, from which experts might be sent to the Colonies, and from which our own great proprietors of woodlands would, doubtless, often too gladly supply their wants for foresters. We have now, in India, a fair number of educated foresters, who know their work well, and some of whom, at least, are men of high professional attainments, able to hold their own with the highly educated foresters of the Continent. It is not too much to hope that the services of some of these men might be utilised to teach forestry at home and to put in order some portions of forest in England and Scotland, where practical instruction in the what is known as the natural system of sylviculture, might be given. Thus, in due course, England might become independent of foreign countries for the education of her foresters.

PART II.

It will be now right that I should, with your permission, explain, as briefly as possible, what are the principles of forest management as taught in these schools.

Forestry divides itself into two branches; the first is called sylviculture, or the culture of woodlands in all that concerns the crop which grows upon them; the second refers to their administration from an economic point of view, or in regard to the supply of timber for sale or use by the community, and the revenue to be derived from them.

As regards the first, it may be said that there is no mystery in scientific forestry. It means simply to observe the action of nature in a forest, and to follow it, or to utilise it for our advantage, when we are able to do so. Its object, then, should be to obtain the utmost possible advantage from the soil by keeping it always covered by a growing crop of trees; and, when the trees arrive at maturity, to remove them in such a a manner that the smallest possible interruption may be caused to the productive work of nature in the forest.

Now, the natural reproduction of a forest when the trees are removed, is the corollary of the above considerations. In a natural state, the reproduction of a forest is effected by

the germination of the seed which falls from the trees in it whenever the necessary air, light, and warmth are admitted to the ground by the fall of any tree, either from accident or age; the work being carried out gradually, and the soil never being exposed over any large area at once. For the young seedlings which spring up would wither and perish at once, unless they were sufficiently shaded. So in forest operations, when the time has come for the removal of the timber, on no account should the ground be anywhere cleared of trees at once; but a commencement should be made by felling a tree here and there, and so breaking the thick cover of the forest, to allow sufficient air and light to reach the ground, and so cause the seed which has fallen to germinate. In this way, about one-fifth of the mature trees should be removed every five or six years, never breaking the cover by making large gaps in it, but taking a tree here and there, and always leaving the finest and most vigorous trees till the last; so that in about thirty years the whole of the old trees will be cleared off, and a new forest established in their place. Thus the seeding of the forest will be effected by the agency of the finest trees, which will be themselves all the while increasing in bulk, and thus the productive power of the soil will be utilised to the fullest possible amount. A short calculation will show that a tree, 10 feet in girth, which makes a ring of wood of only one-eighth of an inch in thickness, adds to its bulk at the rate of rather more than one cubic foot of timber annually for every 10 feet of the length of its stem; or, in other words, such a tree, if its stem be 30 feet in height, will, in 30 years, have increased in bulk by at least 100 cubic feet of solid timber. At the same time, during these 30 years, the young trees which are springing up will become perfectly hardy, and capable of supporting the whole force of the summer heat and winter frost. Nothing, then, is lost by the system of natural reproduction, as must be the case when a forest is cut down to be re-planted; for not only in the latter case is there a degradation of soil from exposure, but also a dead loss in the production of woody material during the whole time that both the old crop and the young can remain on the ground together with mutual advantage.

But it is not only in the removal of the timber and the reproduction of the forest, that we ought to study the action of nature. It is equally necessary that we should do so in the felling for improving the growing crop, or, as they are commonly called, thinnings. To understand this, let us glance at the constitution of a high timber forest, in its natural state, that is to say, a forest, whatever be its age, springing from seed, and therefore capable of living and thriving through a long series of years. In such a forest the trees will, when young, form an almost impenetrable thicket of various heights; later

on, they begin to assume a definite form, and being in close contact with each other, they soon begin gradually to lose their lower branches, which fall off and wither; but as a compensation, they throw all the vigour of their growth into their heads; and as these push themselves upwards, seeking the light of the sun, the stronger ones overtake the weaker, so that a certain number of the latter perish and disappear each year. When about half their full age, the trees will have attained their full height; but from that time till they arrive at maturity they go on always augmenting the diameter of their stems, but at the same time decreasing in number; so we may calculate that, if 1,600 trees of four inches in diameter can stand and thrive on an acre of ground, there will not be above 400 when the trees are eight inches, 200 when they have attained twelve inches, and from 100 to 140 when they are sixteen inches in diameter. In our thinning operations, then, these considerations should be our guide. In the early stages of a forest's growth, there is little to be done except to keep the heads of the young trees of the most valuable species from being overtopped by those which stand near them; and this can be best done, not by removing the others, but by cutting off or breaking their tops; for it is in this stage that the process of natural pruning is going on, which nature does so much better herself than we can do it for her, and to this end it is necessary that the trees should grow as close as possible together. Later on, when the trees have taken a more regular form, we can assist nature, and, at the same time, save much valuable produce by judicious thinnings, which should be arranged so as to pass through the whole forest at intervals of from ten to fifteen years, so that the whole area may be operated on in turn. In executing these, the most delicate of all forest operations, it will be well to remember that their object is to give room to the heads of the trees, and not to their stems; for the stems will never be too close together, as long as the heads have room properly to develop themselves. The details, however, which govern the operation of thinning differ for almost every species of tree operated on, and to touch on them would be to enter upon a whole course of lectures on forestry. It will be enough to say here that, in every case, the favouring of the most promising trees, and the removal of the weaker ones, together with the preservation of continuous shade to the surface of the ground, while all the trees have sufficient room to grow, should be the object aimed at.

The second point to be considered is the administration of forests from an economic point of view, or with reference to the revenue to be derived from them.

Now, the basis on which all sound forest management depends, is the revenue which any forest can be made to pay—that is to say, the income which it will produce in proportion

to the volume of the standing trees; or, in other words, its capitalised value. This principle has been accepted as the base of the science, equally in the French as in the German Schools, which, differing considerably, as they do, in the details of forest treatment, both start from this same point. To this end a forest should be considered as so much capital, represented by so many cubic feet of wood; while the amount of wood produced each year, by its growth, represents the interest thereon, and, in fact, is the revenue of the forest. It is evident that it is possible to cut and remove every year a quantity of timber equal to this annual increase of wood, without diminishing the volume of the standing crop. The quantity that can be so removed is the proper yield of the forest—that is to say, the continuous yield; and French foresters have called it "the possibility"—or possible annual yield—of the forest.

Now, if we suppose that a period of 150 years will be required for the youngest trees in a forest to arrive at maturity, it is evident that the 150th portion of it might be felled every year, and that the increase of timber in the rest of the forest would equal the volume taken away. But, as we cannot apply such a plan in practice, and at the same time insure the reproduction of a high timber forest, we arrive at the possible annual yield in another way.

1*st*.—In order that we may have to deal only with areas of a workable size, the forest is divided, in the first place, into large blocks, or divisions, which should not be more than 2,500 or 3,000 acres each, and arranged generally so as to be convenient for the roads, rivers, or other means of transport for the timber. Each of these must be considered and dealt with as a separate forest by itself; and to each a period is assigned, in which the whole of the present crop of trees will be removed, and the youngest now on the ground will have come to maturity. This will be about 200 years for oaks, 120 to 150 for beeches and Scotch firs, and so on. These divisions are again subdivided into (usually) four or five working subdivisions or compartments, to each of which a sub-period of *thirty years or thereabouts is assigned, as being sufficient for* the removal of all the old trees in it, and the reproduction of the new crop. There must be, then, as many sub-periods in the number of years assigned for the complete working out of the forest, as there are sub-divisions in the whole forest. We take whichever of these sub-divisions contains the greatest number of mature trees, and assign to it the first sub-period of 30 years, calling it No. 1. We count and measure the trees in it (neglecting all, if there be any, of less than four inches in diameter), and ascertain the total volume of timber they contain. *This, divided by 30, or whatever is the number,* the number of years in the sub-period will give, as is evident, an amount or volume of timber somewhat short of the possible

annual yield, but near enough to it for all practical purposes; it remains, then, only to remove, each year, from this compartment the quota of timber indicated above, following, in doing so, the method for the reproduction of forests explained just above—that is, we should remove one-fifth of the trees from one-sixth of the surface of the sub-division each year, or thereabouts, taking care not to exceed the volume indicated as the possible annual crop.*

The other sub-divisions or counterparts will be numbered 2, 3, 4, &c., and to each of them a sub-period will be assigned in succession. In the meanwhile, the necessary thinnings and the removal of trees that would otherwise perish, must be carried on continually during the first sub-period in all the other sub-divisions, so as to go over the whole ground at regular intervals, not exceeding 15 years each. At the conclusion of the first period, No. 1 will contain a young crop of trees *from 1 to 30 years old; and then No. 2 will be* taking in hand, and after No. 2, then No. 3, and so on, until, in the full period, the whole forest will have been renewed without the ground having been once entirely cleared of trees. Anyone visiting Baden Baden will do well to explore the forests in the beautiful valleys of the Oos and the Murg, in its immediate neighbourhood, which furnish a splendid example of the successful working of forests on this system. These forests are easy of access, being on the high road to Switzerland, and I mention them on that account. As examples of private forests, which have been admirably managed in the same way, I may mention those of Prince Furstenburg, near Rippoldsau, to the east of Baden Baden, where there are some excellently constructed and most ingenious devices for bringing timber down the mountain torrents to points from which it may be carted away.

But, besides forests which spring from seed, there are others which consist of shoots springing from the stools or stumps of trees which have been felled, and which are commonly called coppiced forests. In many cases these give very *good returns for hop-poles, vinestays,* bark, and other purposes for which large timber is not wanted. Their management is well understood, and the only points on which suggestions may be offered are:—

1*st.*—The necessity of giving sufficiently long intervals between each felling, as every time the copse is cut, the soil suffers from exposure, and its fertilising power is wasted, as it is also by the production, during the first four or five years after the cutting, of a mass of useless grass and leaves, which profit nothing.

* Trees cannot be made to grow spontaneously in a forest, as we can place the men on the squares of a chess-board. The distribution of the fellings must, therefore, really depend on numerous cultural exigencies which develop themselves from time to time which time will not admit our noticing here.

2nd.—The necessity of using sharp instruments for felling, and cutting the wood close to the ground, leaving the stools or stumps of such a form that the wet may run off them. These precautions are necessary for ensuring healthy re-shoots.

3rd.—The cutting of the copse, if possible, in the early spring instead of in the winter, as is usually the case. If the work is done just before the sap begins to move, the shoots are made at once, before wet and rot have attacked the stools, and rendered the production of healthy, vigorous shoots impossible.

It may be added that the more standard trees that are reserved in a coppiced forest, the greater will be its value; and there is nothing to prevent their flourishing over the lower growth, which serves to keep up their heads and to give them a clean stem.

Now, what is the practical application of all this? We have in Scotland about 800,000 acres of forest which have been *planted during the last hundred years, for few of them exceed* that age. Besides these, there are a small remnant of the old natural forests in Strathspey. In England we have, belonging to the Crown, about 50,000 acres of forest, the greater portion of which has been planted within the last hundred years also, with some remnants of the old natural forest, chiefly in the New Forest. It is impossible to speak too highly of the admirable work done by the able men who have created these forests at Scone, Bait Athol, Dunkeld, in Strathspey, on the Findhorn, and at Beaulv, in Scotland, as well as in some of the English Crown Forests. In our Colonies, including India, there are millions and millions of acres of forest land, some of which is of the greatest value, so that Great Britain is, perhaps, the country most richly endowed in forest wealth, of all the countries of the earth. Every one, not only in our own country, but elsewhere, is interested that all this great forest-wealth should not be wasted or frittered away by a single generation of men. But, nevertheless, what is the future of all the forests? I have visited many of them, and scarcely anywhere did I see any of that young growth which is the link *uniting the forest now on the ground with that of the future.* Can any one say, then, that the future of these forests is assured? As at present they exist, one of two conditions must befall them. Either they will be cut down and the timber sold, or they will, in due course, perish naturally, and disappear of themselves. In either case the result is deeply to be deplored, for when once a forest disappears, it can only be replaced at a great expense of time and money.

It is for this reason that I am here to advocate the establishment—be it on the smallest scale even, to commence with—of some system of national instruction in scientific forestry. Hitherto, we have been entirely dependent on Continental schools for this training, and at the present moment we have

officers of the French forest service, who have been lent to the British Government, at the head of the forest administrations both at the Cape of Good Hope and at Cyprus. It seems, then, time that some stir should be made to help ourselves in this matter. It would, perhaps, suffice at first to establish a course of lectures on forestry at one of our public educational establishments, at which young men desirous of following a forest career might attend; provision being made for their instruction in practical work, if possible, in our own Crown forests, but otherwise in some of the State forests on the Continent. It might be hoped that the Indian and Colonial Governments would, as an encouragement, place some appointments in their forest services at the disposal of young men so educated.

As a proof of what has been already effected in India by the forest officers educated in the Continental schools, I may *mention that in that country there are at the present date* 9,820,000 acres of reserved forests, the whole of which are managed generally on the principles above detailed, and 2,493,000 of which are protected from fire, as well as cattle and sheep grazing, and, consequently, are now in a condition to reproduce themselves under the natural system; and as, perhaps, the most convincing proof, from a practical point of view of the value of the system, I may add that the forest revenue of India, which in 1870 was only £357,000, with a net revenue of £52,000, in 1880 reached £545,000, with a net revenue of £215,000. That is to say, the revenue had increased 56 per cent., while the charges had only increased 8 per cent.

In South Australia a serious commencement has been made in the right direction also. By an Act passed in 1873, the sum of £2 per acre is paid to landowners, in certain districts of the colony, to form plantations of trees. In 1875, a Forest Board was constituted, as certain districts of the colony were formally defined as forest reserves. In 1878, a Forest Act was passed, and a conservator of forests (Mr. Brown) was appointed. Last year, about a quarter of a million trees were planted out, *and the forest revenue amounted to £6,517*—of which £1,380 was for timber sold—against an expenditure of £6,200.

If then, so much has been done by the Indian and Colonial Governments to secure the future of their forests, can nothing be accomplished at the head-quarters of the Empire? This is the question now before us, and I trust that it may be answered, by instituting a course of instruction which may eventually develop into a forest school for Great Britain.

DISCUSSION.

Sir Richard Temple, G.C.S.I., said he had great pleasure in standing by the side of his old friend and comrade, Colonel

Pearson, who began his forest career under him some twenty years ago. They had together threaded the dense thickets of India, and admired the broad trunks, spreading branches, and magnificent heads of the forest trees; and, though Colonel Pearson suffered a great deal from the malarious climate, he braved all dangers and hardships manfully for the sake of the forests he loved so well; and to-day there was no one more competent to speak on this important subject. There was not the same inducement to preserve the forests in England as in some Eastern countries, because here it was to a great extent a question of wealth, but in Eastern countries it was a question of climate also. Here, trees were preserved to a great extent for the sake of ornament, and as a shelter for game. As had been mentioned, England was naturally well endowed with trees, and to this he, as a small West country landowner, could bear testimony; but unfortunately, since the gales of last October, the timber which had strewed the ground had been rather a drug in the market. He could vouch for the excellent forestry which was carried out in Scotland, and all who had travelled on the Continent were aware of the excellent schools of forestry which existed both in France and Germany. He could not say much about Spain and Italy, but he had lately been through Denmark, which was as bare of trees as the palm of one's hand; on crossing over to Sweden, however, you came to a region where the trees were really preserved as a source of national wealth in the most perfect manner possible. In America, no doubt forestry was somewhat behind hand, and before long the eastern part would get into great difficulties unless more care was exercised. With regard to establishing a school of forestry in England, he did not see how it could be done unless there were State forests. He had examined the subject when in Scotland, where he delivered a lecture on the subject; and, though there were magnificent forests there, the proprietors of which would no doubt allow facilities for their inspection by students, and for instruction being given by the foresters in whose charge they were, so far as possible consistently *with their more immediate duties*, these advantages would not be sufficient, unless the forests were absolutely under State control. If such a school were formed, there would no doubt be ample scope for the employment of the students in the eastern and other portions of the British Empire, and he was sorry Sir Bartle Frere was not present, for he was sure he would have borne testimony to the necessity of forest conservancy in South Africa. Sir Samuel Baker could have given equally strong testimony with regard to Cyprus, which in classical times was one of the most lovely and fertile of islands, but was now in a wretched condition, and could hardly find means to pay its way. The main cause of its utter denudation in modern times was the destruction of its forests. He rejoiced at this subject being brought before that influential Society, for

there were few matters of more importance to the future of India. The destruction of her forests in former times had been one of the blots on the administrative and statesmanlike escutcheon of England, and it had arisen simply from the ignorance of her governors, individually and collectively. When he went to India, he was supposed to have had a liberal education, but he had never heard a word about forestry, and he feared that many of those who came after him were not much better in this respect, though there might be some little improvement. There were great interests in India, all arrayed against the forests—all wanting to live upon them. Colonel Pearson had pointed out the difference between drawing an interest from the forest, and using up the capital, or *corpus*, as lawyers called it, which all selfish and short-sighted people were inclined to do; but it was the duty of the Government to come forward and protect forests, in the interests of the people themselves. If it had been *neglected, it was simply because the Government had* been uninformed, and for that reason alone he should hail with great satisfaction the establishment of a forest school in this country, as it would afford a means of diffusing a knowledge of forestry amongst the civil servants of India. We had before our eyes the most frequent examples of the consequences of disforesting. What was the cause of Palestine, Syria, Asia Minor, and parts of Mesopotamia being so utterly barren and destitute, compared to what they were in ancient times? People attributed it to invasions and revolutions, but it was owing far more to disforesting. Many of the beautiful hills, which long before the Christian era were well clad, were now utterly bare, and thus the climate became affected, the rivers and harbours silted up, as was shown at Ephesus and the mouth of the river near Tarsus. Again the same thing was the cause of the fearful famines in China; the Chinese were excellent agriculturists; as regards manuring they were ahead of every nation in the world, but the art of forestry had been long extinct among them. He would not stay to speak in detail of the Indian famines, but having served through them, he could say that one of the *causes, probably the main cause of the droughts, was the* destruction of forests in past times. What England thought to-day India would think to-morrow, and, therefore, he hoped this subject would be heartily taken up. A great deal had been said of the French forest schools, and it should not be forgotten that they were due to the Emperor Napoleon III.*

Mr. J. C. Rogers said the Surveyors' Institution, of which he was secretary, had for a long time taken a great interest in this subject; and when Dr. Brandis first established the Indian Forest Department in 1867, the council of that Society made strenuous efforts, but without avail, to combat the notion that it was necessary to send all the students to France or Germany.

* *Note.*—We do not quite understand this statement.—ED.

They held that there were magnificent and well-managed forests in Great Britain, and that means might be found at home for educating the candidates for the Indian Forest Department; but a deputation which waited on the Duke of Argyll, then Secretary of State for India, met with a signal rebuff, and was informed that an inflexible rule had been laid down that all such candidates must attend the French or German schools. About 1875, the Institution drew up a number of questions, which were sent to the Colonial and Foreign Offices, asking for information as to the management of forests in the various European countries and in our dependencies, and about two years later a most alarming budget of information was received in reply, containing such a vast quantity of details that it was impossible for any individual to deal with it. At length, in the summer of 1878, feeling ashamed that nothing was done with this very valuable information, he undertook to deal with that part of it *which related to the British dependencies, and after six months'* hard work, managed to compile a considerable book, containing all that was valuable in the returns, supplemented from other sources, and this book was published as a Parliamentary paper; but coming out at an unfortunate time, he feared that it had almost escaped public notice. He believed, however, that it was this publication which first called attention to the alarming evils with which they were threatened by the mismanagement of forests. He did not deal with India, as there was already a scheme in full operation there, but he dealt with all the colonies, and pointed out that South Australia was the only place in which any care was being bestowed on this question. In some places the periodicity of the rainfall had been greatly affected, and the ruthless destruction of the timber in the neighbourhood of settlements frequently caused great economic difficulties. In many cases colonies would be almost deprived of fuel altogether in case of a war, in which Great Britain temporarily lost her naval supremacy. This return had anticipated many of the statements of Colonel Pearson, and it had been freely quoted in several cases without the customary acknowledgment, though not on the present occasion.

Mr. John Robinson, as a forester of 40 years' experience, felt much obliged to Colonel Pearson for the capital paper he had brought forward; and he was particularly pleased to find he advocated the establishment of a school of forestry in England. Sir Richard Temple had spoken of the wealth of England in this department; but no man ought to be allowed to throw away his wealth, as was done here, merely by the neglect of plantations which had been started. In many parts of England, and in some parts of Scotland, it would be found that plantations which had been made at the Government expense had failed, from the incompetency of those who managed them. He remembered, some years ago, reading in a paper on this subject,

the pith of which was contained in these few words: "Plant thickly, thin quickly." The nurserymen took care that the first injunction should be obeyed, but the other part was generally neglected. Like the last speaker, he had been endeavouring for some years past to induce the Government to take up this question, and he hoped he had attained a certain amount of success with the late administration; but just then a change came, and nothing was done. He did not think it was altogether hopeless to establish a school of forestry in Edinburgh, where there were already facilities for affording the young forester information in the cognate branches of his education, such as geology, botany, &c., and an arboretum had recently been purchased by the municipality, and his contention was, that if the Government would endow a professor of forestry, the thing might be accomplished. Something was being done by Sir Joseph Hooker at Kew, and he hoped that one result of this paper would be the formation of a committee which should make renewed efforts to induce the Government to take the matter up, and establish a school of forestry in Great Britain, not only for the sake of India, but also for the instruction of land agents and others who had to manage estates at home, so that the largest amount of profit might be obtained from the numberless forests in our own country.

Mr. Thiselton Dyer, F.R.S., thought it was desirable to keep as much as possible to the point raised by the paper; and though Mr. Robinson's remarks were very suggestive, he feared they had a tendency to raise a cross issue. The British Empire covered a large part of the surface of the globe, and the real problem was how to arrange that the forest resources of the different countries under our charge did not suffer such a deterioration as would, on the one hand, injuriously affect the climate of those countries, and on the other deprive our fellow subjects in the future of the material resources obtainable from those forests. No one who had studied the information which had been gradually acquired on this subject, could doubt that there was grave cause for anxiety. You could not go on felling forests indefinitely without producing an artificial state of things which, if not watched with care, would ultimately produce complications of the gravest kind. He had listened with great interest to the remarks of Mr. Rogers, and he could assure him that his work was by no means thrown away. A copy of his book was amongst the papers at Kew, and he felt that it was a document of the greatest importance with reference to the statistics of this subject; and when the question gradually ripened into a shape in which it would attract the attention of political persons, it would be referred to as the starting point from which any action should be taken. The alteration of the surface of occupied countries, and the removal of forests, required to be approached with some caution. For

instance, in England it was not a very pressing question; and though he had seen a paper drawn up for the India Office by one of the professors of the school at Nancy, in which it was stated that Scotland had once 20 million acres of forests, whereas now there were but three-quarters of a million, he did not know that the material prosperity of Scotland had suffered by the change. You could not lay down a broad principle that the removal of woods in temperate climates must be regarded as a disaster. On the other hand, in the south of France, the removal of the forests from some of the Alpine slopes, in the interest of agriculture, had led to disastrous floods, one of which, in 1875, caused damage to the extent of £3,000,000, and the Government was now going to great expense to replant those slopes. This was a question which most affected our fellow-citizens in the hotter portions of our possessions. Cyprus had already been mentioned, and it was in *many respects* a typical instance. He did not know how far it could be taken as true that the island was once covered with forests; but, at present, such as were left, were in the last stage of dilapidation. A report had been made upon them by an *Indian forest officer*, who was of opinion that within the present generation what remained of the forest would probably perish. The rainfall was only thirteen inches, and it immediately flowed off the surface, so that, in the language of the *report, instead of a forest* you had a desert. A French forester, who was selected by Colonel Pearson to go there, estimated that with a quarter of a million outlay something might be done in half a century; but where was the money to come from? When the forests of such a country as Cyprus were destroyed, it was like a burnt cinder. Many of the West Indian islands were in much the same condition, and the rate with which the destruction took place when once commenced was almost *incredible*. In the Island of Mauritius, in 1835, about three-fourths of the soil was in the condition of primeval forest, *viz.*, 300,000 acres; in 1879 the acreage was reduced to 70,000; and in the next year, when an exact survey was made by an *Indian forest officer*, he stated that the only forest worth speaking of was about 35,000 acres. Of that, the portion in the possession of the Crown had had every stick of available timber cut, and those parts in the possession of private owners were still worse. Although there had been no apparent diminution in the rainfall, the humidity of the air had diminished, and the springs were drying up. Again, taking Ceylon, in 1873, Sir William Gregory, ascending a mountain in the centre of the island, 8,000 feet in height, said the eye ranged in every direction over an unbroken range of forest; but six years later, when the present governor made the same ascent, the whole forest had disappeared, and the ground had been parted with so rapidly by the Government that it had not

even retained sites for police-stations, and had to repurchase them. In Jamaica, again, it appeared that nearly all the timber required for building purposes had to be imported. In Ceylon, the denudation of the forests was accompanied by a deterioration in the soil; and the Rev. R. Abbay, who went there on the eclipse expedition, calculated, from the percentage of solid matter in a stream, that one-third of an inch per annum was being washed away from the cultivated surface of the island. In some colonies the timber was being destroyed at such a rate as would soon lead to economic difficulties. In New Brunswick, for instance, it appeared that the hemlock spruce, the bark of which was used for tanning, was rapidly disappearing—one manufacturer in Boiestown using 100,000 trees every year for this purpose. In Demerara, one of the most important and valuable trees, the green heart, was in a fair way of being exterminated. They actually cut down small saplings to *make rollers on which to roll the large trunks.* In New Zealand, again, Captain Walker said he feared the present generation would see the extermination of the kauri pine, one of the most important trees. All these facts showed that this was a most urgent question which at no distant date would have to be vigorously dealt with. Mauritius, Cyprus, and Ceylon had obtained the assistance of the Indian Forest Department, but it must be remembered that the gentlemen of that department had duties of their own to perform, and there would be an increasing difficulty in getting the requisite assistance from that quarter. Then there were those who were educated at the French school, but there were certain disadvantages in employing the services of foreigners in English dependencies. Lastly, a certain number of men from Kew had been utilised, and he was glad to say that their efforts were highly spoken of, but it must be remembered that they had not had such advantages as were desirable in forest officers, so that none of these sources seemed likely to be able to give a permanent supply of the men that were required, and hence it was manifest that some new establishment was urgently needed.

Mr. Hyde Clarke said he believed this subject had been taken up by the Society a century ago; and he was convinced that, if a representation were made to the Council, a committee would be appointed, which would probably lead to some practical result. His memory did not quite bear out what Colonel Pearson had said with regard to their past deficiencies in this respect; he had alluded to the history of the subject in the time of Queen Elizabeth, and he believed it would be found that continuous attention had been given to the production of timber in this country for various purposes. He might remark, also, that some of their friends from India were sometimes inclined to press the matter too far. Sir Richard Temple had referred to Ephesus, but he (Mr. Hyde Clarke) could by no

means trace the silting up there to the destruction of the forests. He did not believe the forests were ever greater in that district than they were now; and with regard to the southern parts, he had had a great deal of timber from those very forests.

Mr. Boulger remarked that there was the same encouragement in England for the establishment of a school of forestry as had been operative in America, *viz.*, the willingness of private individuals to avail themselves of its advantages, of which he could speak from personal experience. In 1876, when he was at the Agricultural College at Cirencester, he was requested to deliver a course of lectures on sylviculture, preparatory to the examination of the Highland Agricultural Society of Edinburgh, and he then gave what he thought must have been the first course of lectures on the subject ever delivered in England. In Oxford there had been for 200 years a professor of botany and rural economy, but he feared the latter subject had been swallowed up by the former. At the present time the students of forestry in England laboured under great disadvantages, for even at Cirencester, though he was in the same country as the Forest of Dean, he was too far off to take his pupils for any practical work to that admirably managed forest. As Colonel Pearson had said, for a forest school you require a State forest, such did not exist in Scotland, and he hardly thought a newly-established arboretum could take its place. A wood was one thing, and a forest another; the Forest of Dean was a State forest, and possibly arrangements might be made for teaching forestry in connection with Cirencester College. At the present time forest officers went to India from this country at the rate of six per annum, which was not a large number. They were educated at first mainly in London, and a great many had passed under his hands during the last three years, to be promoted in scientific subjects, but such work was eminently unsatisfactory, seeing that the plane trees in the London squares were the principal illustrations at command. Then they went to Nancy, where they had to hear lectures in a foreign language, and though no doubt the proficiency they were compelled to attain in French was an advantage, the system had many drawbacks. He learned from some of his pupils that they had to begin all their science over again in French. This difficulty would be removed by the establishment of a forest school in England, and he believed that some of the French forest officers had testified to the admirable way in which the forest of Dean and other State forests in England were managed. After all, the principles of forest cultivation were the same all the world over, though there might be differences of climate and species to take into account.

Mr. Liggins said he remembered in his early days, in the West Indies, there was a great controversy as to the proper

way of dealing with the forests—one side maintaining that all the trees should be cut down to prevent the roots interfering with the canes, whilst others contended that, if the trees were destroyed, there would be no rain, and they would get no crops at all. He had naturally taken a great interest in the subject ever since, but was never able to learn anything about it in this country; whereas, in visiting the last Paris Exhibition, he found there was abundant information attainable. He might state that timber for buildings was not imported into Jamaica because there was none in the island, but because the native timber was so valuable, hard, and expensive to work, that it was cheaper to import pitch-pine and other soft wood. He could not altogether agree with Mr. Boulger that London was such an unsuitable place for teaching science; a great deal might be learned here where men of every science met together, and the student would have his mind fertilised generally. An *immense deal of mischief had been done in Demerara*, Barbadoes, and other West Indian islands, from the destruction of trees, and it was most desirable, in the interest of all the colonies, that a central school should be founded where young men might be trained in this most important branch of knowledge.

Mr. William Body said he had the authority of one of the largest agriculturists of this country for the statement that there were thousands of acres on the sides of hills and slopes which might be advantageously planted with trees at a cost of £10 to £12 an acre, which would yield a handsome profit. He had known two instances in which the timber on an estate had been sold for nearly as much as the whole purchase money, and having had some experience in planting, he was very well satisfied with the results.

General Strachey, C.S.I., F.R.S., said he might almost consider himself the dry nurse of the Indian Forest Department, having assisted at its birth, and watched its development into one of the most successful branches of the administration. The Indian Government, under the pressure of necessity, had *developed this department; it had* required its officers to study at Nancy, acting under the advice of Dr. Brandis, and the system had so far proved very successful. But, as had been remarked, there were obvious disadvantages connected with the system, and for some time it had been the desire of the Indian Government to obtain for its forest officers the necessary education in England. That idea was about to be acted upon, and no doubt before long a school would be established here, whether the Home Government joined in it or not.

Mr. Rowland Hamilton hoped the suggestion of Mr. Hyde Clark would not be lost sight of. The subject would attract the attention of many other societies, such as the Colonial Institute, the Statistical and Agricultural Societies, and the

Social Science Association, who would all aid in bringing the matter under the notice of Government, if the Society of Arts appointed a committee to deal with it.

The Chairman, in proposing a vote of thanks to Colonel Pearson, referred to the statement that the net revenue from the forests of India had been increased during the last ten years by £200,000, in great measure by the effects of the Indian Forest Department; and as that Department had been so greatly aided by Colonel Pearson, they owed him a double debt of gratitude. Some advantage might, perhaps, be derived from the present depression in agriculture, if it forced those who were dependent on the land for their income to consider whether they might not do much to improve its value by the establishment of schools and colleges for instruction in agriculture and also in forestry. Even in Scotland, although the forests were generally well managed, there seemed a general consensus of opinion that there were large tracts of country which might be planted with advantage. It certainly was an anomaly that a country like England, which owned some of the largest forests in the world, was the only great country which had no forest school; and it would no doubt be a great satisfaction to Colonel Pearson if the discussion that evening should prove the first step towards the establishment of a forest school worthy of the British Empire.

The vote of thanks having been carried—

Colonel Pearson, in reply, said he was much gratified by the cordial reception which had been accorded to his paper. He must tell Mr. Rogers that his paper had been very much appreciated in France, for it had been tabulated and re-tabulated by the professors at Nancy, and used in their lectures, and questions were set upon it; and there was no doubt that if a forest school were established in England that return would form one of the principal documents referred to. He would point out that such a school would have to do a double work, though it might be connected, partially, at any rate. A certain amount of instruction was needed by surveyors and land agents who were to practise in this country; but those who were to go to India and the Colonies must be provided with a wider scientific training than would suffice in the former case, were any information on special points connected with mineralogy, geology, &c., could be obtained without difficulty when required.

Report on a Visit to the English and Scotch Forests by the Professors and Students from Nancy Forest School. By M. Boppe, Inspector of French Forests.

THE total area of Scotland is about 20,000,000 acres, hardly one quarter of which may be reckoned as arable, forest, or pasture land, the remainder being occupied by the lakes, rivers, peat-mosses, moorlands, bare rocks and mountains. It is surprising then to find that against such a vast area of uncultivated ground only 734,490 acres, according to the official returns of 1872, are classed as woodlands.

There is every reason to suppose that, at a remote period, both the highlands and lowlands of Scotland were covered by dense forests, which were successively destroyed by the fire and steel of conquerors, and during the anarchy existing under the old feudal system, as well as by the fearful storms which at almost regular intervals sweep over certain districts. So complete, indeed, was this devastation that, in 1707, all that remained of the grand old Caledonian forests were a few shreds, and those in a most deplorable condition.

From the union of the two kingdoms dates a period of political calm, during which, time and the marvellous timber-producing properties of the soil and climate would have done much to repair the ruin, had not the sheep, the arch-enemy of all forest vegetation, been allowed to retain his footing in the forest.

The noblemen and great landed proprietors of Scotland at last felt the necessity of doing something to restore the parks and woodlands in the immediate vicinity of their mansions, and by the introduction of plantations to vary the sombre monotony of the boundless heather. It was also necessary on these bare moors, where grazing and shooting form the main sources of revenue, to furnish shelter for the cattle, sheep, and deer. Their example was soon followed by the smaller proprietors, and, under the wise patronage of the "Select Society" of Edinburgh, founded in 1754, the area of forest land augmented rapidly, so that in 1812 Scotland possessed, besides 500,000 acres of natural forest, about 400,000 acres of plantations.

The year 1815 marks a pause in the work of replanting which had been so vigorously begun. We do not pretend to enter here into the various causes which led to this economical phenomenon, but it is certain that the laws of 1686, on the constitution of landed properties in Scotland, exercised a baneful influence on the rational cultivation of the soil. The Scottish Parliament in vain sought to counteract the Draconian regulations of these laws, the principal effect of which was to cause the proprietors to look on themselves as only life tenants of the entailed estates, and consequently to take but a very

slight interest in the improvement of the soil, and the augmentation of its pecuniary value.

From the moment the planting ceased the area of woodland diminished, and necessarily so, for in any forest where sheep have free entrance the removal of a tree, whether by the axe of the wood-cutter, or by the violence of the wind, causes an empty space which can only be refilled by resorting to artificial means. It is thus that the returns of 1872, as compared with those of 1812, show a diminution of some 200,000 acres in the area of forest land in Scotland. Whether it was a portion of the old natural forests, or the newly-planted ones that had disappeared during this period of 60 years, the documents extant do not show. There is, however, good reason to suppose that both suffered equally in this respect. For, on the one hand, the construction of the Highland Railway necessitated the employment of a large number of sleepers, which could be procured from the woods of *from 50 to 80 years of age, along* the line of route; and, on the other hand, the increased facilities of transport, and the scarcity of wood in England, gave an unexpected value to certain tracts covered with birch, and so tempted many of the proprietors to cut down the old forests composed of this species.

In 1870, the work of replanting seems to have recommenced with increased ardour, and on all sides may be seen young plantations vigorously striving to fill up the gap which separates them from those of half a century's standing.

Such, in a few words, is a brief outline of the history of the forests which we have had the good fortune to visit, under the guidance of our excellent friend, Colonel Pearson. Thanks to the kind forethought of the authorities at the India Office, and to the hearty welcome which we everywhere received from the great landowners and their agents, our flying visit was accomplished in a most agreeable and instructive manner. We eagerly seize this opportunity of offering to all concerned with it our sincere and hearty thanks. We would fain also express to the eminent personages who did us the honour of receiving us *so graciously, that we accepted their kind marks of attention* as being addressed, not only to ourselves, but also to the French Government and the Forest School at Nancy, which year by year, since 1868, has offered to the English students, without any distinction of nationality, the advantages of a forest education.

Before proceeding to a description of our tour, it will perhaps render the narrative more intelligible if we give a brief sketch of the country we visited, its general aspect, and natural resources.

From a forest point of view, Scotland may be divided into two distinct regions, by an imaginary line drawn from Perth, on the Firth of Tay to Greenock, on the estuary of the Clyde.

To the south of this line we find the lowlands, a country which agriculture and manufactures have combined to render one of the richest in the world. The economic situation of this wealthy district is as prosperous as possible, and the thoroughly developed system of high farming which is there employed leaves but little room for forest cultivation. The lowlands are bounded on the south by the Cheviot Hills, which afford excellent sheep walks. To the north of this line lie the highlands, intersected in all directions by the far-stretching chain of the Grampians, whose rugged nature gives to the country an aspect not unlike that of the western coast of the Scandinavain peninsula. One would imagine that at some earlier geological period immense polar glaciers, flowing over the solidified North Sea, traversed the whole of the north of Scotland, polishing on their way the mountain sides, excavating the lake beds, and breaking off abruptly the cliffs surrounding the coast. The culture of cereals is here confined to a few favoured localities, situated near the mouths of the rivers or on the low-lying ground bordering the sea, where the glacial deposits constitute an excellent soil. The rest of the country is wholly occupied by water and heather, and thus out of the 13,000,000 acres which this region comprises, only 1,600,000 (or less than one-eighth) are classed as arable, forest, and pasture lands. If out of the remaining 11,000,000 acres of unproductive land we allow a half for the lakes, bare ridges, and sterile mountain tops, there will still remain 5,000,000 acres capable of furnishing valuable timber forests. Here then is a problem for British economists, and a vast field for enterprise and capital.

Highland forests.

In the highlands, to which we principally directed our attention, the districts around Perth, Elgin, and Inverness are those in which the most extensive forests are to be found. These three counties together contain about 247,700 acres of forest, and being well served by the Highland Railway system, these are easier to visit than any of the other Scotch forests. Starting from Perth, we made our way across the highlands, visiting *en route* the towns of Dunkeld, Blair Athole, Aviemore, Grantown, Forres, Inverness, and Beauly. We were thus enabled not only to make an inspection of some of the finest forests in Scotland, but at the same time to obtain a fair idea of the general aspect of the country. The punctuality and precision, so thoroughly characteristic of Englishmen, with which all the details of our journey were arranged by Colonel Pearson, added to the hearty reception we met with at every turn, enabled us, in the short time at our disposal, to thoroughly inspect more than 100,000 acres of every description of forest under ever varying physical and geological conditions. Everywhere, both at a few feet above the sea level and on the sides of mountains at a height of 2,500 feet, in the sands of Forres and

in the schists, red sandstones, granites, and gneiss of the interior, we were struck by the wonderful aptitude of the soil for forest vegetation, favoured as it is by a regular climate and the constant humidity of the atmosphere.

In the low-lying districts, at an altitude of from 250 to 300 feet, we found growing, both singly along the roadside and collectively in the forests, magnificent specimens of oak, maple, elm, ash, beech, and lime, which, by the vigour of their growth, and the rich colouring of their foliage, bore testimony to the favourable conditions of soil and climate under which they grew. We were struck with admiration in beholding the colossal trees of every description forming the avenues at Scone, Dunkeld, Blair Athole, and Darnaway. It was near the first of these places that the venerable father of Scotch forestry, Mr. McCorquodale, showed us, with legitimate pride, a small oak forest of about 400 acres, which 60 years before he had himself assisted to plant. In this forest, the trees were standing about 24 to 30 feet apart, and their diameters measured from 12 to 18 inches, whilst their magnificent tops formed a perfect canopy of leaves above the bright rhododendrons, in which colonies of young pheasants found a home. In the spring time this ought indeed to be a fairy-like spot. But, independently of this undergrowth, which is after all only suitable for the wealthy few, we cannot help thinking that a more careful study of this superb forest would go far towards clearing up some of the doubts which have always surrounded the difficult question of the cultivation of forests composed solely of oak.

The mountain vegetation commences at about 400 feet above the level of the sea; beyond this we find ourselves in the domains of the Scotch fir, the larch, and the birch.

In selecting the Scotch fir as the tree to be cultivated before all others in these regions, the promoters of forest plantation during the latter half of the past century, showed no mean proof of their thorough appreciation of the natural requirements of the soil and climate of the highlands, for not only have they ensured the success of their operations, but they have traced out the best line of action for their successors.

Equally fortunate were they in their endeavour to introduce the larch into Scotland; transported from the ice-bound summits of the Alps to a country where the climate is tempered by the softening influence of the Gulf stream, this tree does not appear to have suffered to any material extent by so sudden a change of latitude.

When, in 1737, the Duke of Athole brought home, amongst his baggage, as a kind of remembrance of his travels in the Tyrol, the seeds which were sown in his park, and from which sprung the first larches in Scotland, he rendered a most valuable service to his country.

From a forest point of view, the results obtained by the cultivation of these two species (Scotch fir and larch), are truly marvellous. Any one who has seen the beautiful larch forests planted in 1815 on the banks of Loch Ordie and the vast stretches of Scotch fir covering the flanks of the Bruarwood mountain, cannot fail to admit that the question of replanting of the Scotch highlands is partically answered.

The absence of the beech from all the forests of any standing is easily accounted for by the fact that it is only quite recently that the timber of this tree has become of any value for industrial purposes. For many cultural reasons, however, the beech is a tree of the highest importance, and we should strongly recommend its introduction into all future plantations, and it is, moreover, as much indigenous as the Scotch fir and birch. In many cases even it might with great advantage be substituted for this latter, or better still mixed with it.

Considering, too, the wonderful success that has attended the introduction of the larch, we think that a similar attempt might be made to acclimatize the *Pinus montana* in the peat mosses. These immense sponges, so to speak, which cover sometimes entire districts, discharge their dark-coloured waters into all the streams, and give to the lakes and rivers of Scotland that sombre tint which is so peculiar to them. The fuel which they afford is of very second-rate quality, and supposing that half the surface was converted into plantations, there would still be enough peat left to keep going all the whiskey stills on the country side.

As foresters of the Continental school, accustomed to live among forests regularly managed, and having for their sole object the production of timber, we had no little difficulty in understanding the widely different motives which actuate forest cultivation in this country. Everywhere we found the forests fenced in on all sides with walls and hedges; and, as a matter of fact, the forester or agent generally carries the keys of the gates in his pocket. We learn that these costly enclosures were erected, not for the purpose of keeping out the cattle and deer as in the Jura, but for the purpose of keeping them in; it appeared to us like shutting up the wolf in the sheepfold.

We were also struck by the monotonous regularity in the height and age of the trees, unmistakeable sign of their artificial origin, and want of methodical management. The forest, here left to its own devices, continues growing just as the hand of man has planted it; the undergrowth is constantly grazed down by the sheep and cattle, and nature, in spite of the immense resources at her disposal, is quite powerless to modify the work of the planter, or repair the errors committed by wood-cutters.

When, under such circumstances, the time arrives for the trees to be cut down, or should they be uprooted by a hurricane, the forest disappears in its entirety, owing to the total

want of young growth which is necessary as a link between the old forest and the new one which ought to be created. Such, at least, appears to us to be the case in all the forests that we visited in the valley of the Tay and its tributaries, and further north, near the foot of Cairngorm.

Not far from a mansion to which are attached some of the pleasantest recollections of our tour, we saw the remains of a noble forest, which some 20 years ago had been cut down and converted into railway sleepers. The sight of the huge stumps, blackened by time, with their gnarled roots twisting themselves over the ground, gave us the idea of some vast charnel-house. This scene of utter ruin was indeed a sad spectacle, though the present proprietor is doing his best to again cover his estate with timber; with a better system he might have been spared both time and expense. It is easy in Scotland to perpetuate a forest by natural means, and of this a practical proof was given us in two forests which we visited—the one near Grantown, in Strathspey, the other at Beauly. In these the results obtained under the skilful and intelligent direction of the gentleman who manage these forests for his employers form a striking example of what may be done in the way of reproducing forests by natural means. In fact, nothing had been neglected which even the most critical forester could desire; the gradation of age was here complete, and the reservation of specially vigorous trees, of known pedigree, duly carried out.

The *modus operandi* here pursued consists simply in the exclusion of the sheep and deer, in the judicious thinning out of the growing crop, and in the removal of the mature seed-bearing trees, by successive fellings, as the young forest grows up and acquires more vigour.

Nevertheless, we would not have it be supposed that the sheep need be absolutely debarred from all grazing in the forest; it is only in those portions where the undergrowth is very young that the damage caused is irreparable. We feel convinced that if, every year, certain portions of the forest, best capable of supporting it, were marked out for grazing, the quality of the pasturage would be greatly improved, and the heather would quickly disappear under the cover.

It is an established fact, beyond all contradiction, that on any soil, whatever its geological origin, a complete covering of forest vegetation will kill the heather as soon as the trees reach the age of between 30 and 40 years. Suppose then that 120 years be the term fixed for the existence of the trees in any portion of the forest, and that the trees of 100 years of age and over are reserved, there would still be one-half of the forest always open to the sheep, and the other closed. But, at the same time, it is certain that this open half, owing to its superior quality, will furnish pasturage for at least twice as many head of cattle or sheep as the same quantity of moorland.

Although, under ordinary conditions, the regeneration of a forest will be sufficiently assured by the exercise of a discreet control over the grazing, something more than this must be done if it is desired to turn the land to the best possible account. It is, therefore, a matter of regret that nothing has yet been done to place forest management in Scotland on a sound economic basis.

The productive powers of the soil and of the climate have been made use of by able and intelligent planters, who have thereby enabled nature herself to accumulate a considerable store of timber; but all this wealth is exposed to the carelessness of some, and to the ignorance of others, until the hand of a forester manages it properly and places it on the only sound economic principle of all agricultural and forest property—*a constant annual revenue and a constant improvement in production.*

It would certainly not be fair to hold the Scotch foresters responsible for the present regrettable state of affairs, for, though they have for the most part admitted the inefficacy of the present system, they are powerless to effect any improvement so long as the landowners and general public have not learnt to appreciate the manifold advantages to be derived from a regular and methodical management. They have to struggle against many adverse interests and hindrances, such as grazing and shooting interests, questions of routine, pecuniary exigencies, and the fancies of sportsmen from all parts of the world.*

In wishing Scotland, then, a hearty farewell, we venture to predict for her forests a great and prosperous future. It does not need that one should be a very great prophet to predict this for a country where the oak and beech, the Scotch fir and larch, flourish with equal vigour, and where the *Abies Douglasii*, *Abies nobilis*, and *Abies Menziesii*, the *Sequoia*, and the cedar, form mighty trees, in company with *Araucaria* and various exotic shrubs, which only languish miserably under the climate of Paris.

Before leaving this country, however, we would fain add a word of advice, for the moment appears to us a propitious one for deciding on the future welfare of the forests, which, owing to the rapidly increasing value of timber, runs great risk of being compromised. Ordinary fir timber now fetches 8*d.* per cubic foot; larch is worth nearly double that amount. We ourselves visited a forest of Scotch fir, which, at this rate, would be worth 120*l.* an acre, and another of larch worth considerably more; whilst a third forest of 1,600 acres, composed of Scotch fir, was purchased a few years ago for 52,000*l.*, or only about 30*l.* an acre. The plantations on the Culbin Sands, near Forres, would readily find buyers at 50*l.* an acre at the age of forty-five to fifty years. The very day we were at Gran-

* A deer run, over unproductive land, has just been let to an American for nine years at the fabulous rent of 10,000*l.* per annum.

town, the agent for the Strathspey forests concluded a bargain to furnish birchwood to the amount of 2,000*l*.

All these figures are fraught with extreme significance for the future, and the large forest owners of Scotland will do well to pause before allowing their forests to be "overworked." We would recall to their recollection the old fable of the goose that laid the golden eggs.

No doubt, people are often frightened by the long names and big words they find in treatises on scientific forest management, but they may very well neglect the text if only they will adopt some of the principles which they contain. Let the owner of a forest, after having made a careful and detailed inspection of it, divide it off into blocks or compartments so arranged that they should be uniform as regards conditions of soil and of planting, and then proceed to count and measure all the trees of three feet girth and upwards, classing them in categories according to their diameter. He should then open a debit and credit account for each compartment, placing on the debit side the actual volume of the standing crop, and on the credit side the volume of timber removed at each successive felling. This register should always be consulted before undertaking any forest operation, and when the annual fellings fall due, it will show which compartments can best support the withdrawal of timber, and which require to be left untouched. Moreover, the balance sheet will render an exact account, favourable or otherwise, of the condition of the forest.

Ten years of such systematic treatment would form in itself the basis of a regular forest working plan, and the doctor's prescription would no longer frighten the patient with its long words.

Our programme, however, was not yet complete, and fresh excursions awaited us in England. It took us only four days to reach Windsor Forest from Inverness, passing by the Caledonian Canal, and halting at Oban (from whence we visited Staffa and Iona) and Edinburgh, whence we took the train to London.

Windsor Forest.

Even with a four-in-hand and the best of drivers, it would be impossible to see Windsor Forest in such a short time as we had at our disposal.

The history of that noble park has been published in a splendid volume by the late surveyor, but the history of Windsor is, so to say, a repetition of the history of England herself; if we follow all the phases in the development of this park, where, since the time of William the Conqueror, each sovereign in turn has given his name to some remarkable tree, Windsor Park may, with justice, be called the Westminster Abbey of British monumental trees. Its history is one which belongs as much to archæology as it does to sylviculture, while

in it the beautiful deer are almost as numerous as the trees themselves.

Nevertheless, the practical forester may rest assured that, although the first place is here given to art and beauty, he will still be able to find much to interest and instruct him. Windsor Park is indeed one of the most magnificent fields for the study of forest botany, that even the wildest imagination could conjure up. Here may be seen, growing singly or collectively in clumps, specimens of all the finest trees, native or exotic, which exist in Great Britain; and since care has been taken to keep an exact record of the age and origin of each plantation, the forester would be enabled to follow out in detail studies of the highest interest and importance regarding the growth of the principal forest species. It would be more difficult to do the same with regard to their longevity; for one is led to think in looking at some of them, that, in this hallowed ground, trees *never die of old age. One sees in these relics of the past, that* religious respect for things so characteristic of Englishmen, when even the most violent revolutions could pass over the country, and yet leave these monuments and these trees intact.

The surveyor of Windsor Park, who is, by turn, a forest officer, an organizer of shooting parties, a director of the royal workshops, and conservator of a museum of antiquities, can, in consequence, have but little time to devote himself to sylviculture, unless it be to prepare the iron armour, intended to preserve the veterans of the forest in their struggle against the elements, or to prop up with crutches some invalid deprived of a limb by a recent gale.

Having come all the way from Scotland to Windsor, we were not to be alarmed by the journey from there to the New Forest, for a few hours sufficed to carry us to Southampton.

New Forest.

As old as Windsor Park itself, the New Forest has not had the good fortune to be the dependence of a royal residence. The barrenness and poverty of the soil has sufficed to preserve it from being plundered even at an epoch when land was valued more for its extent than *its fertility. But, on the other hand, this very fact attracted a poor* and necessitous population to settle in and around the forest, who, during long ages, have been accustomed to derive a precarious existence from it, and by careless abuses have threatened it with certain ruin. For many centuries the New Forest has thus been a prey to commoners, who use up its resources without either method or control. One may see there the steady onward progress which is made by the heather; and, although it is not perhaps so quick under the feet of the almost wild ponies and cattle as under those of the sheep, yet it is none the less sure.

The sole remedy for this state of things was to restrict the commoners to certain defined localities, and that could only be done by sacrificing a portion of the forest to save the rest.

This is, in fact, what was done about twenty years ago; but the sacrifice has indeed been a heavy one, for the reservation of some 14,000 acres has cost the abandonment of 49,000 more. The part which has been freed, however, is sufficiently extensive to constitute some day a respectable forest, whilst the part given up is hurrying to its destruction in a manner deplorable to behold, and, before very long, there will be nothing left but a worthless barren heath.

It is not, however, in twenty years that a forest, so badly used as the New Forest, can be restored. The first thing to be done was to put the soil in good order, and then to plant some of the vast stretches of heather with firs. Of late years the forest officers have sought, by excluding the cattle, to bring about the natural reproduction of some portions hitherto abandoned to pasturage. But with whatever care these operations may be carried out, at least 50 years must elapse before they can resort to systematic fellings, with a view to furnishing a regular revenue.

At present, contiguous portions of the forest often present the most curious contrasts. On one hand we see young firs and oaks growing side by side; in another place a forest of pure oak, languishing among chestnuts; and in a third plantations of fir and beech, indicating by the vigour of their vegetation, and their healthy appearance, that it is on them that the future of the forest ought to depend. Further on there is a valley filled with aged beeches, whose weird forms gave an almost supernatural aspect to the spot; we almost expected to see the ghost of William Rufus pursuing that of Walter Tyrrell through the haunted forest.

Without contesting the marvellous beauty of some parts of the New Forest, so dear to artists and lovers of nature, we are bound to say that before long it will *not be here* that a professor of sylviculture, desirous of teaching his science, will choose to pitch his tent.

Forest of Dean.

On our return to Lyndhurst, after the excursion in the New Forest, there remained but three days at our disposal before our duties necessitated our return to France. These were employed in visiting the forest of Dean.

The present forest of Dean occupies the site of the old forest of the same name, which formerly covered the whole of the plateau between the estuary of the Severn and the valley of the Wye ("Dean," "dên," signifies "forest" in the old Celtic language). The old forest has disappeared within the last few centuries, owing perhaps to the demand for charcoal and mine-props for the local industries; if, however, we were not afraid of being accused of being prejudiced, we might say that unrestricted pasturage may have had something to do with the disappearance. It is on these ruins that the new

forest of Dean has been created; in less than a century, more than 16,000 acres of the original 22,000 have been replanted. The older plantations are generally of pure oak; the beeches, chestnuts, and birches form but a small percentage of the trees. Scotch fir, spruce fir, and larch are generally only found in the plantations made during the last thirty years, or in bad peaty portions. The state of vegetation is generally good, varying, however, with the quality of the soil, but indicating in every point the artificial nature of the forest.

We may take this opportunity of remarking that a plantation of "broad-leaved" trees (oak, beech, &c.,) takes a much longer time to establish itself than one of "needled-leaved" trees (conifers,—Scotch fir, larch, &c.). In Scotland we saw the most magnificent plantations for larch and fir, whilst in the forest of Dean the plantations of oak were always more or less dwarfed in appearance. The cause of this is that oaks furnish the soil with much less vegetable manure than the coniferous trees; and, again, in an oak plantation there is a marked absence of undershrubs and spontaneous ground vegetation, which, by their organic remains, tend to increase and improve the surface soil. It is rare also that a plantation of oaks, on a soil which has been long unoccupied by forest vegetation, and is but moderate in quality, succeeds well during the first generation; it is only at the second generation that the trees acquire their normal development.

At present, while the trees are yet in their youth, the only cultural operations that can be undertaken are the periodical "thinnings," and these are here conducted with great skill. There is no doubt, however, a great future in store for the forest of Dean, thanks to the workmanlike manner in which it is managed, and to the laws regulating the pasturage which date back to the time of Charles I.

We were not able to suppress a certain vague feeling of sadness in wandering through these endless plantations, rendered so dreary and monotonous by the total absence of that undergrowth which seems to inspire the woods with freshness and life; and it was with a sense of great relief that we emerged from them, and entered into a well-managed forest composed of standard oaks surmounting coppice wood.

This forest, comprising about 3,400 acres, was formerly the property of Lord Gage, and was purchased by the Crown with a view to presenting it to the Duke of Wellington. It is composed of pure oak, and for more than 100 years the coppice has been cut every eighteen years. We might add that the reserved trees form the staple element in this forest, for the coppice forms but a small proportion of the standing crop. These reserves, varying in age from 20 to 100 years, are in an excellent state of vegetation, and number about 80 trees to the acre. The largest trees are about four or five feet in girth, and from 25

to 35 feet in height of stem. It would be a great pity to cut them until they have attained at least double their present age. This forest would form an excellent field for the study of the treatment of standard oaks.

In such a forest, where the soil is so exceptionally fertile, it might be possible to find a solution to the oft-discussed problem of obtaining the maximum production in quality and quantity from a forest of oak. This was, at least, the impression we carried away with us as we turned our faces homewards.

Forest School in Great Britain.

We had barely sufficient time, on our arrival in London, to pay our respects to the authorities at the India Office, when we were asked by Sir Louis Mallet to place on record the observations which we have now the honor to submit, and to state whether, in our opinion, the immediate foundation of a Forest School in Great Britain is possible. In order to reply to this question, it was *necessary for us, even at the risk of our narrative* being found tedious, to enter into a somewhat detailed account of the Scotch and English forests.

Were it only for the purpose of replanting the five or six millions of moor and waste land which covered one-third of the highlands, we should consider there was a sufficient reason for the formation of such a school. The question, however, must be studied on broader grounds.

Considering the present depressed state of agriculture all over Europe, it becomes more and more necessary to endeavour to draw the greatest possible advantage from the land, and, by properly adapting a different vegetation to different soils, to seek to obtain, through the medium of the enormous capital which the present generation can command, the maximum production from a minimum area. It is thus that the forests are called upon to play an important part in the immediate future, and the farmer will henceforth find a powerful auxiliary in the forester.

After making every allowance for the great fertility of the soil in Great Britain, we feel certain that in many districts *more than one of the forests which were cleared some time* back would now be jealously preserved by the same proprietors who formerly cut them down to satisfy their pressing wants.

It must also be borne in mind that the British Empire is not confined to Great Britain and Ireland, and that, by reason of her immense possessions, England is, perhaps, of all nations in the world, the one most richly endowed with valuable timber forests. It is by hundreds and millions of acres that we may reckon the forests of Canada, India, and Australia, New Zealand and Cape Colony, not to speak of those in the West Indies and Borneo.* All these natural sources of wealth are worked by

* The total extent of the forests in the British possessions is 340,000,000 acres of timbered land.

British enterprise and British capital, and, consequent on the present wonderful development of commerce throughout the globe, it is a matter of importance to every civilized nation that this vast accumulation of forest riches should not fall into the hands of ignorant persons, or be squandered away regardless of the future.

For these reasons the establishment of a Forest School in England becomes a matter of primary importance.

Necessity for a Reserved Forest.

The science of forestry is, however, a science of observation, based upon facts which must be studied both from a practical and theoretical point of view. It is, therefore, absolutely necessary that a Forest School should have attached to it a forest which has for some time past been under scientific management, serving, so to speak, as a natural laboratory for experiments, and without which the best theoretical teaching in the world would be of no avail. This is especially the case in England, where the young men, by reason of their national character and their mode of education, are accustomed to pay more attention to facts than to theories; here the teacher of a technical profession, resting solely on theories, would command very few disciples.

It is, therefore, a matter of regret that, among all the forests visited by us in our travels, there is not a single one suitable for the teaching of sylviculture on that broad basis so essential when the pupils are called upon to apply it in all quarters of the globe. In England, as in Scotland, all the woodlands may be arranged in two categories,—the one containing plantations too young, recently created by the hand of man, the other containing plantations too old, or too much overworked, to be useful for the purpose; nowhere did we see a high timber forest formed of really mature trees.

Natural forest required.

Moreover, a plantation must always be incomplete as a field of study, and especially for persons who will generally have to deal with natural forests. Nature, ever prodigal of her bounties, if left to herself, scatters them broadcast without any regard for the particular wants and requirements of man. It is then the work of the forester to control this generous prodigality, and, by careful selection, to concentrate her fertilizing powers on such trees as are best adapted to meet the general demand. In the case of a plantation there is no need for this interference; here natural selection, the struggle for supremacy amongst the different species, and even art herself, can play but a very insignificant part in the various phases of its existence.

In a forest, then, of this nature it would only be possible to apply a very limited number of the principles of sylviculture.

A practical Englishman will have no difficulty in understanding our meaning.

It is not to be supposed, however, that the foundation of a Forest School is at present an impossibility, for, while leaving the question of time and place to be settled hereafter, it would be advisable to at once decide, in principle, on its creation; such a decision is the only mode of arriving at its foundation. It is necessary also to take measures for preparing the public mind to regard the science of sylviculture as an additional means of developing the national resources, and to take steps for the gradual creation of accessory forests.

Under control of Forest Officers.

This accessory forest must necessarily be incomplete at first, but would be perfected in time; but the essential point is that it should be placed under the absolute control of the officers of the school. This can only be done by choosing a State *forest. If it should be considered desirable also, in* order to render the teaching more complete, the State ought to purchase or lease in Scotland a forest suitable for the purpose.

Professors of Forest Economy.

We would also suggest the founding of Professorships of "Forest Economy" at two of the great public seats of technical instruction. One of these might be instituted at Coopers' Hill for England, the other at Edinburgh for Scotland.

The professors should be selected from among the young men who have received a thorough forest education on the Continent, and have had eight or ten years' practical experience in India. They should publish, from time to time, a series of articles in the leading agricultural and forest journals, in order to influence the landowners in favour of a systematic management of their woodlands, and to prove to them that uncontrolled pasturage is the certain destruction of forests, and that, in the long run, the timber furnished by forest land is of greater value than pasturage or game.

The establishment of a course of sylviculture at Coopers' Hill would have the great advantage of giving to the young engineers a rudimentary knowledge of a science which cannot fail to be useful to them in their after-career. It would, perhaps, also be possible by this means to modify the present method of recruiting the Indian Forest Service, by offering to the students, at this excellent institution, a certain number of appointments in that service.

The course of instruction afforded at Coopers' Hill would then comprise all the essential parts of the education of a forester, and it would only be necessary to supplement it by sending the selected students for one year to a Continental school, where they would have the opportunity of perfecting themselves in the practical details of forest culture. After this it would be advisable for them, accompanied by their English

Professor, to complete their training by making a tour of inspection in some of the mountain forests of France, Germany, and Austria. So prepared, the young men would be perfectly capable of undertaking forest work in any portion of the Indian Empire.

Recommendations.

In conclusion, we beg to submit the following recommendations :—

1*st*.—That a National Forest School be founded in Great Britain.

2*nd*.—That Professorships of Sylviculture be instituted at Coopers' Hill and at Edinburgh.

Such are the conclusions at which we, in conjunction with our travel ing companions, Messrs. Reuss and Bartet, have arrived, and we feel that an apology is due for their length. This is really due to the excessive courtesy of our hosts, who, jealous of the success of Jules Verne's hero, who made the tour of the world in 80 days, were determined to make us traverse, in less than three weeks, more than 300,000 acres of forest land situated in the most opposite parts of Great Britain, from Duncansby Head to St. Catherine's Point.

The Spanish Chestnut.

SIR,—In the year 1873 seeds of the sweet chestnut were distributed by Government for experimental cultivation to some, if not all, the hil. divisions in the Punjab. In this division (Sutlej) 50 seedlings had been raised by April 1875, of which, in the same year, 30 were put out in good soil, on terraces facing the north, at an elevation of 7,400 feet, with a rainfall of 77 inches, and protected on the east and west by mountain ridges from the prevailing winds.

The remaining twenty were transplanted on the north-east slope of a hill (in a loose sandy loam) in the vicinity of the holm oak, vine and wild olive, at an elevation of 6,200 feet, with a small rainfall.

In the latter situation the plants have made the best progress, and a few of them are ten feet high, and of a shrub-like appearance. In both places, several bore fruit in October 1881; but on opening the thorny cases I found in each of them from three to four shrivelled empty rinds, and I have heard that in Kulu the same has occurred in two gardens.

As I am at a loss to account for this feature in the fruiting of the Spanish chestnut, and as the peculiarities of the several varieties are well known in Europe, perhaps some of your correspondents will be able, through "THE FORESTER," to say whether this is a characteristic of the fruit in the early age of the tree, or to what causes it is due.

G. G. M.

The Forests of South India.

Dear Sir,—It has occurred to me that some of your readers may like to have an account of my first impressions of the forests in South India.

Let me then begin by saying that the greater part of the Peninsula south of the Kistna river is an exceedingly mountainous country, without any of the vast plains which are peculiar to North India and Bengal. About the end of February, on my march from Dindigul to Coimbatore, before crossing the Amravati river, which here divides the Madura and Coimbatore districts, I was astonished to see before me in a north-westerly direction a vast expanse of plains country, without any hills on the horizon. To the north was the Pulney and Anamalai hills, rising to a height of 8,000 feet, the foot of which was only 10 miles distant, but to the north-west there was this wide expanse of level country, the plains of Coimbatore.

In the Cauvery delta and in the delta of the Kistna river no hills are, I believe, visible on the sky line, but these are the only extensive plains in that portion of South India through which I have travelled, and regarding which I am writing.

Another peculiar feature in this part of India are the extensive high tablelands, not flat, but with an undulating surface, sometimes rising into high peaks. Of these the Mysore tableland is the most extensive, a vast area, with an average elevation of 2,500 feet, bounded on the north by the Western Ghats, the mountains of Coorg, and the higher tableland of the Nilgiris, and including besides Wynaad, portions of the Coimbatore, Salem, North Arcot, Cuddapah, and Anantapur districts of the Madras Presidency.

A second tableland, entirely separated from that first-mentioned, much less extensive and much more broken up by deep valleys and ravines, are the Javadie hills, which lie partly in Salem, partly in the North Arcot and South Arcot districts. In the forests of these hills, which rise to an elevation of nearly 4,000 feet, I spent some time in January last, after having devoted November and December to the northern districts. The Javadies are about 40 miles long, and 20 miles wide in their broadest part. The peculiar feature of these hills is, that, except on the outer slopes, which are often steep and rocky, they are covered with a deep layer of good soil, which is protected by dense bamboo forests, with much Sandalwood, a few young trees and numerous old stumps of Teak. In the ravines and valleys the bamboo forests are almost untouched, while on the ridges and slopes the forest shows traces of having been cut and burnt for Ponakád cultivation, which is the same as Kumri on the West Coast, Jhoom in Bengal and Toungya in Burma. The forest on the outer slopes is deciduous, very open, with much grass, and with few large sized trees, except of the useless kinds, such as *Dalbergia paniculata*, *Boswellia* and *Sterculia* and in places difficult of access. Indiscriminate cutting under elaborate rules framed with the best intentions, and the annual jungle fires, have combined to reduce these forests to their present condition. On the plateau, and particularly in the valleys and ravines which were too far from the market, the forest is well stocked, but wherever there was any demand, it is poor and steadily deteriorating.

There are many other smaller plateaux in the Salem and adjoining districts, some of which rise to a greater elevation than the Javadies. On these hills there are often extensive tracts of evergreen forest—the so-called sholas north of Salem. Of the smaller hill ranges the Shevaroys are the best known. The plateau and upper slopes are stocked with flourishing coffee gardens, and Erkad, at an elevation of nearly 5,000 feet, is a pleasant sanitarium during the hot weather for the inhabitants

of Madras and the smaller stations on the east side of the Peninsula. The forest on the slopes of the Shevaroys, particularly on the west and south side, furnishes a satisfactory instance of the good effect of protection. For though no regular reserves with definite boundaries have yet been demarcated, indiscriminate cutting has been prevented during a series of years, and the result is a fairly stocked forest.

It would lead too far were I here to enumerate the many other detached hill ranges in the Salem, South Arcot, Trichinopoly and Madura districts, and I will at once mention the two great plateaux south of Mysore—the Pulneys and the Nilgiris. Both are branches or offshoots from the Western Ghats, and both attain an elevation exceeding 8,000 feet. As regards forest growth we must in both cases distinguish between the plateaux and the outer slopes. The tableland is mostly bare, with stretches of evergreen forest in ravines, but otherwise covered with grass.

These vast areas of undulating grass lands, the grass often mingled with the common Bracken of Europe (*Pteris aquilina*) are a peculiar feature of many high tablelands on the mountains of India. They are found not only on the Nilgiris and the Pulneys, but also on the Khasia hills in Assam, and on the Tu Oo tableland between the Thoungyeen and Houndraw rivers in the Tenasserim division of British Burma. On all these mountain ranges the climate is moist, and the rainfall heavy, the annual fall varying between 50 and 100 inches. The origin of these extensive grass lands, it is not easy to explain. On the Nilgiris and on the Khasia hills there seems but little doubt that at one time the forests were more extensive, and that they have gradually been exterminated by grazing, by shifting cultivation, and by the annual fires. On the Pulneys, the population is, and probably always has been, very scanty, and it is doubtful whether they were ever covered with more forest than at present.

On the Nilgiri plateau a large proportion of the open land is under cultivation. The Badagas plough, or hoe, a piece of land and abandon it after reaping a crop of millet. Grass and low scrub grows up, and at the expiration of a number of years, which varies according to the condition of the land, they retake to the same piece of ground a second time. This practice, together with the grazing of the enormous herds of cattle belonging to these people, and to the Todas, another tribe inhabiting the Nilgiris, and the annual fires, have done much to exterminate the forests. Every jungle fire eats into the edge of the evergreen forest, and leaves a belt of burnt trees and shrubs, which is speedily occupied by thorny scrub and grass. But not on the outer edge only does the forest recede steadily every year, fires are often lit in the heart of the shola, and a blank is produced which becomes larger every year. To

some extent the gradual denudation is counter-balanced by the plantations of Australian Eucalyptus and Acacias as well as of Tea and Cinchona at the higher, and of Coffee at the lower, elevations.

All these cultivated trees and shrubs are exotics, and it is most remarkable to what extent they have altered the appearance of the country. The stations of Ootacamund, Coonoor and Wellington are now surrounded with large trees, chiefly *Eucalyptus globulus*, *Acacia melanoxylon* and *Acacia dealbata*.

As far as I can ascertain, these species were first introduced in 1845, and the oldest trees are 37 years old. The largest Blue Gum trees are from 8 to 12 feet in girth, and are 120 feet high. Before these Australian trees were introduced, efforts were made to cultivate European forest trees, and in many compounds there are specimens of the English Oak (*Quercus pedunculata*). Some of these have grown fairly well, the foliage is full and bushy, and the trees look healthy, but as compared with the Australian Eucalyptus and Acacia they are small and stunted.

The groves of Australian trees are not limited to the vicinity of the stations. Excellent plantations have been made at different places, partly in order to restock sholas or pieces of evergreen forest, but also on open grass land. Thus there are 27 small Government forests of Australian trees aggregating 1,200 acres, scattered over the plateau. Unfortunately they are all of small extent, the two largest being 235 and 200 acres, respectively, while the others are between 70 and 80 acres. Their small size makes it most difficult to protect and manage them in a satisfactory manner. It would be a great advantage both to the fields of the Badagas, as well as to the tea and cinchona plantations in the plateau, if these small plots of forest could be consolidated, and if certain forest belts could be formed, covering the curbs and slopes of the higher ridges. In many places scrub and the remains of old sholas are left, some of which could be planted up with Australian trees. The chief benefit of these belts of forest along the main ridges would be to shelter the lower slopes against winds, to make the land immediately below them more moist and fertile, and to increase the winter supply in the summer springs, which are all over these hills, and from which water is led, often for many miles, long winding channels, similar to those constructed to irrigate paddy fields in the valleys of the North-West Himalaya.

I have called the climate of the Nilgiris moist. The rainfall of both monsoons, the south-west from June to September, and the north-east in November and December, varies from 50 inches at Ootacamund to 100 inches at Neduwattam at the north-western corner of the plateau. But three months, January to March, are exceedingly dry, and during that season

chiefly, but also at other times of the year, the benefit of continuous belts of forest along the ridges would be much felt.

The difficulty will be to obtain permission of the land which intervenes between the existing plantations, and it is possible that the plan can only be partially carried out.

As already mentioned, the chief trees grown in these plantations are the Australian Eucalyptus and Acacias. The Blue Gum (*Eucalyptus globulus*) is a most remarkable and valuable forest tree. In an inspection report of these plantations of 1876, Colonel Beddome estimated the annual yield during the first five or six years at about 1,450 cubic feet, or in dry weight 25 tons per acre per annum (58 cubic feet to the ton). This estimate was based upon a valuation map made by Mr. Gass of two plantations, one called the Newman plantation near Wellington, the other Aramby near Ootacamund. The average size of the trees, as measured by Mr. Gass, is very remarkable :—

	Newman.	*Aramby.*
Age ...	... 5 years	... 12 years.
Girth ...	... 19 inches.	... 84 inches.
Height ...	... 69 feet	... 85 feet.
Cubic contents	... 7¼ cub. ft.	... 23 cub. ft.

These valuation surveys were made in the best portions of these plantations : the average annual yield per acre would therefore be somewhat less than 25 tons, but even if it was only 15 tons, it would be many times greater than the yield of the most productive forests in Europe.

Whatever may have been said regarding the absence of general principles in the forest administration of Madras, it must be acknowledged that the plantations of teak in Malabar, of babool in the tank beds of South Arcot and Tinnevelly, of *Inga dulcis* on the lowlands along the Cauvery river, of Casuarina near the seashore in Nellore and South Arcot, and of Eucalyptus and Acacia on the Nilgiris, deserve the highest praise. It would be an interesting task to determine the quantity of timber and wood produced per acre by these six kinds of trees at different ages, and to construct tables exhibiting their rate of growth. The result would probably be, that in the favorable localities, in which these plantations have been made, the annual yield per acre is much larger than any thing known in Europe. The Blue Gum, however, will always maintain the first place in this respect.

Nor is this Eucalyptus remarkable only on account of its marvellous rate of growth ; its cultivation from seed is easy and certain, and its reproduction from coppice is magnificent. In regard to the reproduction from coppice shoots the two Australian Acacias already mentioned behave in a manner quite different. The Blackwood (*Acacia melanoxylon*), a tall handsome tree with bushy dark-green foliage but of much slower growth than the Blue Gum, does not coppice at all,

except when quite young, while the Silver Wattle (*A. dealbata*) not only throws out numberless coppice shoots from the stems, but covers the ground with thickets of root-suckers, to such an extent that at Ootacamund the tree is regarded as a pest. Large tracts in and near the station are covered with these thickets, consisting of long thin saplings, mostly root-suckers, densely crowded together. These saplings, it is said, increase in size, but the treatment of this tree is evidently not yet fully understood.

It is believed to be useless for fuel, but be this as it may, belts of the wattles, planted on dry ridges, would soon spread, would cover the ground, and would afford shelter against wind and improve the water-supply in springs.

But to return to the Blue Gum. Yesterday I visited the nurseries of a small plantation called Madana, about three miles west of Ootacamund. This was planted with *Acacia melanoxylon* in 1863, was cut down a year or two ago, had not coppiced at all, and is now about to be planted with Blue Gum. The nurseries are in a ravine near a spring, for the seed beds require regular watering until the rains commence. These beds are 22 feet by 3 feet, and are shaded by horizontal roofs of fern and leaves during the dry season. The seeds were sown on the 22nd February and the plants are now about 2 inches high. The cotyledons are two lobed, while the young leaves are linear. In June they will be about 12 inches high and ready for transplanting. The usual plan is to plant them out 6 feet apart, and during the dry weather they are shaded against sun and frost by hoods of leaves and ferns.

A young plantation of the Blue Gum or a tract of coppice shoots has a peculiar light-blue color. The leaves of seedlings and coppice shoots are sessile with a broad base, and opposite, and have a bluish-white color, while the leaves of older trees are green, alternate, petiolate and vertical.

The tree requires much light, and the coppice shoots seem to come up best without any shelter. When a plantation is cut down, the ground gets covered, as soon as the rains set in, with a dense mass of whitish blue shoots, often 10 feet high the first year. The young foliage is not eaten by cattle, and this is fortunate, for no attempt is made to exclude cattle from these plantations. Cattle do however destroy the tender shoots by treading them down, and in this manner large blanks are formed, for no second crop of coppice shoots is produced after the first crop has been destroyed.

The shade of young Blue Gum is dense, but the cover of older trees is light and open. Most of the Government plantations have been made in places formerly occupied by sholas which had been cleared for fuel, and as the Eucalyptus grows older, a dense underwood springs up. This consists of shoots and seedlings of the Shola trees, with an abundance of the yellow bramble (*Rubus ellipticus*) which is as luxuriant here at 7,000 feet

as it is at 5,000 or 6,000 feet in the North-West *Himalaya*. The tall *Lobelia excelsa*, often 15 feet high, with pale blue flowers, stands out from this underwood.

On private estates, plantations of Blue Gum are often found on grass land, and here also the ground gradually covers itself with underwood.

So much regarding the Australian trees in the Nilgiris. If circumstances permit, I hope in another letter to say more regarding the mountains of South India.

D. BRANDIS.

OOTACAMUND, *7th April* 1882.

Ripening of Deodar Seed.

SIR,—I have read with much interest *Mr. A. Smythies'* remarks in your number of January 1882 regarding the "Ripening of Deodar Seed," and beg to forward the results of *my observations on this important question.*

Having only proceeded to the deodar forests of the Tons division, towards the middle of March, my observations of the seed year of 1881-82 only commenced from that time; but I think every one will admit that they tend generally to corroborate *Mr. Smythies'* statements. On the 1st of April last I observed and marked a deodar tree situated on the edge of the Lambatach forest, Garhwal State, and at that time the tree was covered with small cones about three-quarters of an inch long and half an inch in diameter, a few non-fertilized catkins being also visible, as well as the remains of the male flowers, both of which shortly afterwards *fell off, leaving the young* cones *alone* on the tree.

I made careful enquiry from the forester and neighbouring "zemindars" (villagers) regarding the age of these cones, and they all stated without the least hesitation that they were the result of the abundant flowering which took place during the previous October.

According to the statement contained at page 517 of the "Forest Flora," these cones should not have ripened till October 1882, but what afterwards took place tends to shew that some mistake must have been made by the writer of the "Forest Flora."

I again visited this tree on the 18th of July, and at that time the same cones had attained the size of large hens' eggs. The tree was again inspected on the 10th September, and at that time the cones were nearly full grown.

They eventually ripened towards the middle of October, and fell off the tree. Having visited several deodar forests in various parts of the Himalayas, from time to time, I have for some time been rather doubtful of the statement contained at page 517 of the "Forest Flora," but have had no oppor-

tunity of making observations till during the past year; and although these observations did not extend over the whole year as in the case of Mr. Smythies, still I think they tend to demonstrate that in the forests of the Tons division at all events deodar seed takes about twelve months to reach maturity and not twenty-four as stated by Mr. Brandis.

E. McA. Moir.

Sir,—I am able to corroborate Mr. Smythies' statement with reference to the ripening of deodar seed. Finding that the natives of the Bhagirathi valley did not agree with the "Forest Flora" on this point, I proceeded to investigate the matter, and satisfied myself that, so far as the deodar of those parts is concerned, only twelve months are required to ripen the seed. In October 1880 there were no cones of any kind in the trees. In the following May the trees were laden with cones, the size of a walnut, which ripened and shed seed in September-October 1881.

Hardwar, *28th February* 1882. S. Eardley-Wilmot.

Improvement in Divisional Account Offices.

Dear Sir,—Will you allow me, through the medium of the "Forester," to make the following suggestions:—

We may hope one of these days to have the greater part of our Subordinate Forest Establishment composed of men who have been trained to their work at the Forest School at Dehra Dún; would it not be possible for some arrangement to be made by which we could have the assistance of trained accountants in our offices, by a system similar to that followed in the Public Works Department?

In that Department I understand that experienced accountants are supplied to the offices of the Executive Engineers by the Examiner's Office, and probably all Divisional Forest Officers would appreciate a system which would furnish them with clerks who had learnt something of accounts, and who had already *studied the requirements of the Forest Department* Code. Many of us have but one clerk, and must have felt the inconvenience of a change in the office, and the necessity of teaching a new man, who in all probability has an extremely limited idea of accounts, the elements of book-keeping. Even supposing him to be a sharp and willing man, it requires some little time to make him master the compilation of the returns required monthly by the "Code."

It is unnecessary to dwell upon the immense saving of time that would result from a similar system, especially in offices in which one clerk only is allowed. The divisional officer, instead of wasting his time in the office, making out abstracts and doing other work that a man, if trained to it, on,

say, Rs. 50 a month, would do equally well, could then devote his time to the more efficient checking of the accounts of his subordinates, and the better supervision of the work in general.

Would it not be possible for a few men for each province to serve an apprenticeship in the Comptroller-General's (Forest) Office, where, under the immediate supervision of one of his assistants, they might acquire a practical knowledge of the preparation of the accounts required by the "Code," and from whom the divisional offices could be supplied with clerks as required?

If only two or three were thus trained for each province, a grant being allowed as in the case of probationers at the Forest School, a great improvement would take place in our office establishments. Rs. 100 a month would be amply sufficient for these apprentices.

It may be argued that there is not sufficient inducement to good men to offer themselves for these clerkships, and that men who go through this training would expect something better than the maximum of Rs. 50 allowed for the head clerks of most of our offices. I do not think this would be the case, and there would always be the prospect of an appointment in the Conservator's, or possibly the forest branch of the Comptroller-General's Office on higher pay; but for good men, such as we should get by a similar system, it would probably be considered better to increase the pay now sanctioned for our clerks.

It would also be worthy of consideration whether a little practical work in the keeping of depôts, and the attendant books and returns as laid down in the Code, would not be a useful addition to the work now taught at Dehra Dún

E. G. C.

V. Notes, Queries and Extracts.

We extract the following from a note on the successful cultivation of the Carob tree in Hazaribagh :—

On the 15th July 1878, I received three plants. They were from seeds sown in pots, and were transplanted when about four inches high, and I have noted their growth since, which has been as follows :—

Date		Tree No. 1. ft. in.	Tree No. 2. ft. in.	Tree No 3. ft. in.
1st July 1879	...	1 4	1 3	1 1
1st October „	...	2 6	2 0	1 8
2nd January 1880	...	4 0	2 9	2 6
4th March „	...	5 4	3 6	3 6
9th September „	...	7 2	5 3	5 3

Nos. 2 and 3 have been allowed to grow without being pruned, whereas No. 1 has been pruned and trained to form a tree ; its longest and lowest branches measure 2 feet 7 inches in length, while the bottom branches of the two, allowed to grow as shrubs, are 4 feet 3 inches long. The plant, therefore, appears to be inclined to form a bush more than a tree if let alone, notwithstanding that the plant pruned exceeds by far the other two in height.

On the 28th October 1879, I received from the Agricultural and Horticultural Society, Lahore, 623 seeds, and almost all these have germinated, and are now from 12 to 18 inches high.

The practical knowledge thus acquired enables me to offer the following *observations* :—

1*st*.—The seed before sowing must be well soaked in water ; some seeds will imbibe moisture and swell enough for sowing in a few days, while others have taken weeks, and a few over two months.

2*nd*.—That to grow a carob plantation, the seed should be sown just where the trees are intended to be grown, and the trees left undisturbed. I have found that plants thus grown, and the trees left undisturbed, are far stronger and healthier than those transplanted either from pots or the open ground. Besides, there is much difficulty in transplanting, as the roots take a downward course, and plants 14 or 16 inches high will have roots 30 inches long.

3*rd*.—That manuring and watering are not absolutely necessary. I have plants that have been manured, and plants that have been watered, three times a week before sunrise during the summer months, and neither

of them show any improvement over plants that were left without water or manure. The plant once germinated requires nothing more than keeping free from weeds and jungle.

4th.—That neither sun nor frost in any way interferes with the growth of the young seedlings.

6th.—The plant grows quicker in the dry season than during the rains.

7th.—Protection from cattle, &c., is all that is required, and good dry soil.

BLOCKS of wood for stout pavement in London are now cut on a large scale in many forest districts of Northern Europe. Large quantities of round blocks of beech are cut with saws specially constructed for that purpose, at Friedrichsruhe, one of the estates belonging to Prince Bismarck. The blocks are *laid in cement and are said to last well*, and to be in every respect suitable.

This is a matter of considerable importance, for it has of late years become more and more difficult to find customers for the wood of the beech, formerly the most important fuel in North Europe, but now almost entirely displaced by the use of mineral coal.—D. B.

THE MADRAS GOVERNMENT'S CINCHONA ENTERPRIZE.—The result of communications which have passed between the local and the Madras Chambers of Commerce is likely to alter the prevalent opinion in reference to the Government of India continuing to hold their Nilgiris plantations. We suspect few of our readers will have been prepared for the smallness of the figures representing the total shipments of bark from Madras to London from the commencement of the cinchona enterprize to the end of 1881. The table begins with a shipment of 21 bales weighing 3,188½lbs. in 1871, and closes with seven consignments during last year amounting to 340,000lbs., while the aggregate of the *exports for the ten years is no more than 976,108lbs.*, or less than half the present annual export from Ceylon. An annual export of from three to four hundred thousand pounds of bark from Madras cannot be of much significance, considering that it is not the intention of the Government to increase the area under cultivation in their plantations. Still it would be much better for the private planter if the bark were locally utilized for the manufacture of sulphate of quinine and other alkaloids, as in Sikhim. When we recall the very valuable scientific and practical information obtained through the operation of the Government enterprise on the Nilgiris, and the great room there still is, under the intelligent management of Mr. Rowson and his

colleagues and superiors, for further experiment and the settlement of many moot points, we quite agree with Mr. Grant-Duff that the period when the Government should transfer their few thousands of acres into private hands should be carefully considered. But that is no reason why the natural complement of the present cultivation in the establishment of a *local manufactory should not be forced* on Governor Grant-Duff's attention. There is room for a vastly increased consumption of cinchona alkaloids among the millions of Southern India, and with a manufactory on the spot, the Government would undoubtedly be much more liberal in the distribution of the product. Let the practice of liberal distribution to dispensaries and a taste for the febrifuge once be established in India and China, and we have no doubt of a rapidly progressive consumption which would especially benefit the producers of bark.

We annex the return received by the *local Chamber* through the Madras Chamber of Commerce, and signed by Lieut.-Col. R. S. Jago, Deputy Conservator of Forests in charge—Ootacamund, 24th November 1881.

Statement showing the quantity of bark shipped for the London Market from the beginning of the Cinchona Enterprise.

Date of Government Orders.			No. of Bales.	Quantity: lb.
4th August	1871, No.	1,339	21	3,188½
7th March	1872, „	404	12	4 106
5th September	1873, „	952	139	23,646
24th March	1875, „	480	278	28.659½
21st March	1876, „	399	636	63,600
9th February	1877, „	580	261	26.100
27th „	1877, „	644 ...	368	35,800
			265	26,480
11th June	1877, „	1,041	135	13,500
21st January	1878, „	98	577	59,658
21st February	1878, „	276	165	16,260½
18th March	1878, „	413	582	57,033
23rd December	1878, „	2,060	304	31 875
16th January	1879, „	112	215	21 500
28th February	1879, „	500	486	50,596
19th September	1879, „	1,902	440	44,313
17th January	1880, „	66	728	73,424
10th March	1880, „	309	536	54,190
7th April	1880, „	432	16	1,612
26th January	1881, „	185	1,465	153,044
8th March	1881, „	416	305	31 337
16th May	1881, „	771	488	51,355
15th July	1881, „	1,079	56	5.697
Despatched recently (in 3 consignments)		...	960	100,134
		TOTAL ...	9,428	976,108½

—*Tropical Agriculturist.*

Forestry in Mountain Districts.—Whilst the legislation of this country is feeling its way towards some remedial measures in reference to the increasing injury arising from floods, it may interest our readers to learn that so far back as the years 1860 and 1864 the French Government passed laws in reference to the planting and turfing of mountain districts with the view of preventing the formation of torrents. We are indebted to M. P. Demontzey (who holds the important position of Conservateur des Forêts) for this information, together with a vast mass of details as to the carrying out of the necessary works. M. Demontzey is well qualified to be the author of a practical treatise on the replanting and grassing of mountains, and the work is certified by the Ministers of Agriculture and Commerce.

The French Government, having the advantage of a Forestry Department, are more alive to the necessities of assisting proprietors to make improvements. We proceed to give a brief outline of the objects sought and the results. The laws to which we have referred have two branches—one of encouragement, the other of restriction. The former consists in the powers given to the State to stimulate proprietors, by grants of money and material, to replant and renew unproductive soils or exhausted pastures, of which the actual condition would contribute either to the formation of new torrents or the extension of existing ones. This measure is applicable to all mountain regions. It is essentially preventitive in its action, having for its final aim the maintenance and protection of the soil by a series of replanting or regrassing, which the law has named *optional*, and which are thus useful to the general interest, as well as advantageous to proprietors. The means of coercion give the right to improve in the name of public utility similar works called *obligatory*, of which a preliminary inquiry has proved the imperious necessity. The one is for prevention, the other for cure where the malady exists.

The object of these two laws may be thus described: On one hand, to prevent the formation of torrents by the consolidation of the soil on mountain surfaces; a result obtained by optional planting and turfing, and even sometimes by obligatory turfing. On the other hand, to suppress the effects of actual torrents by obligatory works of both kinds. Finally, to obtain and maintain by the results of these two primary effects the regulation of torrential rivers and the protection of valleys below.

The observation of scientific men led to the conclusion that torrents, which rend the mountains and destroy their valleys, are one of the most powerful auxiliaries of those inundations increasingly frequent in the plains, and that the primary cause of the formation, as also of the extension of torrents, was the removal of trees. M. Surell established this theory in his

"Etudes sur les Torrents des Alpes," and demonstrated the following propositions:—

1. The presence of a forest on a soil prevents the formation of torrents.

2. The destruction of a forest leaves the soil a prey to torrents.

3. The development of forests causes the extinction of torrents.

4. The fall of forests redoubles the violence of torrents, even causing them to be re-formed.

It was admitted during the discussions of the law of 1864 that in special cases the forest might be replaced advantageously, at least in part, by the close vegetation of a grassy sward. These principles being established, it was necessary to go to work gradually, and above all to carry out a series of experiments of such duration and extent as would secure unimpeachable evidence. Moreover, the laws being declared tentative, the funds supplied were only sufficient for preliminary experience. It is now more than sixteen years ago since the work was commenced. The numerous studies which have resulted, the valuable observations that have been made, and, lastly, the undeniable and living proofs obtained, have victoriously silenced all objections. M. Demontzey tells us that in the higher regions of the Alps, the classic ground of torrents, one can see now numerous forests of resinous trees suitable to the climate, showing vigorous growth, not only in the basins of reception of primary torrents attacked by these works, but even on their steep banks, fixed and protected for ever; whilst these torrents themselves, once so formidable, have become streams not only harmless but most valuable, inasmuch as they supply good and abundant water for irrigation. The earlier chapters treat of the description and formation of torrents; their effect in the heart of the mountain, description of preparatory operations, and action of dams. This portion of the work is well and numerously illustrated, and a careful study of the drawings will assist in understanding the various means adopted to alter the character of torrents and prevent their mischievous character.

The next portion of the work treats of planting. The object to be obtained is a woody vegetation which possesses the following conditions:—

1. Roots so powerful as to inclose the soils with their numerous rootlets as in a net, so making them more porous and protecting them against being washed away.

2. To afford a sufficient cover to shelter the surface from meteorological influences.

3. To furnish humus more and more abundant, valuable on the one hand to fertilize the soil, and thus increase the growth; and on the other, to furnish the retardation and the regulation of rain water or snow falling on the surface.

4. To maintain, without momentary and perpetual interruption, these salutary effects and develop them by the use of lime.

Useful information is afforded as to the selection of trees. A mixture of Alpine and silver fir with oak seems to have done best in the climate of the Alps. Corsican and Austrian pines are also favourably mentioned.

The necessary preparation of the surface for the reception of either the seed or the young trees, and which is required to a greater or less extent, according as climatic conditions are favourable or unfavourable, are described at great length. The various modes of executing works of planting and growing are carefully described, these works having been obligatory. The details as to optional works, assisted by grants from Government, are given with great minuteness, and, to some extent, are but a repetition of information previously given.—*Field*, 26*th November* 1881.

Disafforestment in Sikkim.—In connection with the Cinchona Plantations at Darjeeling, Colonel Beddome remarks:—

"It is very sad to see how all these grand Sikkim valleys have been denuded of all virgin forest between an elevation of about 1,000 feet from the foot up to nearly 6,000 feet. In 1848, when this portion of Sikkim became British territory, these valleys were nearly all one continuous forest. The Nepalese then were allowed in and they cleared in every direction for maize, murwah (ragi) and other hill cultivation; they stopped their destruction at about 6,000 feet in elevation as the climate there is too cold and bleak, and a belt at the foot of the mountains was left as unhealthy and too hot. Reserves are now formed by Government in the forests above 6,000 feet, very cold situations, where the growth is very slow, and also in the unhealthy forests at the foot; but Government did not recognize the necessity of reserves until it was too late to form them where they were of greatest value and most required. All the country now between 1,200 feet and 6,000 feet has been turned into poor secondary forest, with such trees as Mallotus, Macaranga and Eurya (the same genera which appear with us in similar places although different species) or poor scrub, or in many places grass lands with very rank large species of grass. Similar destruction has gone on in British Bhootan until within the last year or two, that country having been one sheet of splendid virgin forest about eight years ago. There was no grass land proper on these hills prior to the clearings for hill cultivation; the country was all one continuous forest. No one could now possibly visit any of the valleys in British Sikkim without at once acknowledging how important it is that the State should form Forest Reserves."—*Tropical Agriculturist.*

A Forest Festival.—A large number of the lovers of forests assembled at Boston, U.S., at the end of October, says the *North-western Lumberman*, to join in the festival of the Forests, as they poetically express it. It was really a meeting of a committee appointed by the officials of the town of Medford, to consider what steps were advisable to preserve the Middlesex fells region in a natural state. The following report was read :—

The committee is fully convinced by the stumps it has seen that there is not a single one of the multitude of rocky hills within this tract which has not at some time in the past been covered by large and flourishing white pine trees, and, of course, they may be again, and in a comparatively short time, if the proper and not very expensive conditions are supplied. These are, a little soil where the more or less horizontal rock surface has become extensively bare, seedlings planted, and exemption from fires. Fires are fatal to young pines and hemlocks, and that is the reason why the hills are now mostly covered with scrubby oaks and other trees that sprout from the roots. These deciduous trees, even if exempted from fires, do not attain any considerable size, except in the valleys, which, in the fells, are comparatively narrow. Then, if fed with the muck, which is a nuisance in the reservoirs, ash, maple, oak, and black walnut would grow luxuriantly.

White pines ask almost nothing from the ground, except anchorage, and that they find for themselves in the cracks of the rocks. They take their food and rapidly build up their beautiful and perennial shades and venerable trunks from the air, and no tree does more to adorn the winter landscape, to absorb and decompose the gases deleterious to lung and life, appropriating the carbon and restoring the oxygen. They are the most effective as well as the most delightful purifiers of the air, and the density of the summer shade does the most to prevent the evaporation of the water.

That all the land of this tract, not occupied by the reservoirs of water and the residences and gardens of the people charged with the care of it, should be covered with the densest forest possible, is too obvious to need proof. Otherwise the sun will drink more water from these fells than the people.

The progress, if not the perpetuity, of the human race on this good planet depends on the forests of the future. This is the teaching of history, as well as of chemistry and meteorology. Two hundred years ago men had a right to more fields and less woods on this continent, but the war has already been carried too far, and if a healthy population is to increase, the tree population must increase, with equal pace, from what it now is.

The *reasons* why the propagation and care of forests should, to some extent, be a Governmental function, and not be left wholly to private caprice, are :—

(1). Individual life is too short to have trees planted during its period come to maturity. The individual proprietor of land, especially if not very wealthy, is prone to cut his crop of trees before it is ripe, and as clean as he does his rye, thus creating a desert.

(2). A forest, in the absence of fire, never dies any more than a good government; therefore, a good government will take care that no forest, in a fit place, shall ever be killed.

(3). Getting the best results from a forest requires a science and skill which but few individual proprietors can be expected to have. They all will best acquire such science and skill by seeing good examples on a large scale.

(4). Pure air and pure water are common interests. Private caprice, ignorance, or greed should not be allowed to injure them.

Preserving the purity of the air, especially, is not only a municipal but a national and world question.—*Timber Trades' Journal.*

New Zealand Timber.—According to our contemporary, *Land*, "New Zealand is doing a roaring trade in timber." This somewhat astounding statement is qualified, however, by the information that the New Zealand timber merchants have petitioned the Government to make experiments between the New Zealand timber and European oak, in the hope that a favourable comparison will extend their trade. What shape the experiments will take the writer does not inform us. Furthermore, Paris is to be the selected spot for the test between the two woods. French oak, we may observe, is said to be equal to British in durability and strength. What it is the New Zealanders are driving at, or what possible beneficial result they expect to obtain by a comparison between Kaurie pine and oak, it is difficult to surmise. The experiment is to be under the supervision of eminent foresters, and the result will be looked for with interest. We should think so! Why stop at oak? While they were about it the New Zealanders might as well have gone in for teak, greenheart, ironbark, &c.; in fact, the whole genus of hardwoods. The whole thing reads like an absurdity, and if our cousins in the Antipodes wish to continue their "roaring trade" in timber, they had better leave well alone, and not institute invidious comparisons.

If Kaurie pine should be proved to excel in every respect European oak, the demand for it here would still be only of a limited kind. The freight and other charges would swallow up the profit and render an even flowing trade in wood of the kind almost impracticable. When we have hardwoods fit for every conceivable purpose almost at our doors, what on earth should induce us to go 16,000 miles for similar description? If

the colonials can put the stuff on board at Auckland, Otago, or wherever it is shipped, for next door to nothing, there might be a chance of extending the "roaring trade" our contemporary speaks of; as they cannot afford this, we fear the French experiment will leave things in this respect pretty much as it found them, and New Zealand timber will, as heretofore, come to the European markets in limited quantities.

We must not be supposed to underestimate the good qualities of *this valuable wood, which for most* purposes stands unrivalled, but with the rapid growth of steamers wooden lower masts will be less and less in request. Then there is the regular trade done in Oregon to combat, the freight from which is less than what it would be from New Zealand. If the comparison were instituted between Oregon and Kaurie pine, and the question of freight discussed, some practical result might be arrived at.—*Ibid.*

AUSTRALIAN FOREST TREES.—A towering giant indeed is the Wellingtonia of California, but the gum tree of Australia—mounting over 400 feet, able, if placed beside St. Paul's Cathedral, to throw a shadow over it, and having timber enough to construct a big ship out of a single stem—is the vegetable monarch of earth. Few things strike the young gum-sucker on a visit to the land of his forefathers more than the diminutive size of our forest trees. He smiles when he hears praises of mighty oaks. The wonder of the kangaroo country is not confined to the size of its timber, but extends to the variety of their species, and the economical uses to which they could be devoted.

The first tree brought into requisition by the early Sydney settlers was a species of palm, the stem of which was easily used in building. The curled top served for cabbage, giving the plant the name of cabbage palm, while the fibre made the celebrated cabbage tree hats of bushmen. In Adelaide the reed beds supplied the first colonists with framework for dwellings. In Melbourne the stringy bark gave a covering for roofs and slabs for hut sides. As progress went on pine forests and cedar belts were invaded for more convenient and valuable woods. The furniture-makers, not content with these, sought more rare and beautiful material in Australian shades. Coopers and veneerers, wheelwrights and gunmakers, carpenters and shipwrights, tanners and dyers, with other tradesmen, looked for special timbers. The chemist had his objects of search, and the druggist added precious medicines from colonial forests.

Queensland is favoured even in favoured Australia with a variety of valuable woods. In a work on the "Resources of Queensland," it is said that the most useful trees for building purposes are the stringy bark, the gums, cedars, pine, cypress

pine, kauri pine, red mahogany, yellow-wood, citron-scented gum, ash, beech, brigalow, iron-bark, box, blackbutt, blood-red, &c. Those for veneering are forest oak or beefwood, red cedar, sweet plum, satinwood, sandalwood, and ebony. For staves, silky oak, tulipwood, stavewood, and boyum-boyum are used; for flooring, stringy bark and white pine; for wheelwright's work, sour plum, blue gum, and apple tree; for turnery, scrub rosewood; for gunstocks, a species of acacia; for dyeing, cockspur thorn; for ship-building, gums and white mangrove; for bark-tanning, several kinds of wattle, ironwood, and mangrove; for hoops, hoopwood; for medicinal bark, crab tree, fever tree, and cascarilla; for cabinetwork, yellow-wood, Queensland nut, native lime, tulipwood, broad-leaved cherry-tree, scrub lignum-vitæ, weeping myall, iron wood, and mountain cherry. But the apple, cherry, plum, beech, and oak are misleading names, not being like the Eng ish trees.

The eucalypts, including the varieties of gum, are valuable far more than timber. As antimiasmatics the gum products are most important. The great secret of the healthiness of Australia, even of the tropical portions of Queensland, is the exhalation from the forest. The aroma is not more pleasant than it is fever-chasing. The great febrifugal property of the gum tree family is supposed to lie in the eucalyptin, which is yellow in colour, without smell, but having a bitter taste. The leaves yield that substance in addition to fruit, sugar, and several distinct acids useful in the arts. The medicinal kino is obtained from the resin, though the kino differs according to the species. Gum leaves have been used there for the extraction of illuminating gas. From dried red gum bark 2½ per cent. of kino tannin has been obtained, and 16½ of kino red. The double oxide of hydrogen, got from grey gum, is a valuable antiseptic for hygienic use.

The Queensland cedar is red, white, or pencil, prevailing in scrubs near the sea. The Moreton Bay pine rises 200 feet. The Moreton Bay fig throws down roots from the branches after the banyan character. Some figs are 40 feet round, having great wall-like abutments of the root above ground. The beech has a very hard wood. The Leichhardt tree is soft, but takes a good polish. The kauri pine is fine-grained. The cypress is fragrant and useful. The yellow-wood takes a capital polish, as does the satinwood. The chestnut has a dark walnut-like wood and magnificent foliage. The silky oak (a Grevillea) is admired by cabinet-workers and coopers. The mahogany of Rockhampton is hard and tough, red in colour, with a soft bark used for illuminating purposes. The myall is a violet-scented acacia, the wood of which is extensively used for tobacco pipes.—*Journal of Horticulture.—Ibid.*

THE LOSS OF TIMBER BY THE LATE FOREST FIRES IN CANADA.—The Dominion Government, says the *North-western Lumberman*, employs what are denominated "bush rangers," who take care of the Government's timber limits. Since the great fires of last summer, bush rangers and agents have been ordered to, as nearly as possible, ascertain the amount of damage caused to timber by these conflagrations. Estimates have already been made of the loss in the Ottawa valley, and it is placed at 5,000,000 dols. In the territory bordering on the Muskoka and Parry Sound districts, and thence eastward to the townships along the Ottawa, little or nothing is yet known of the amount of loss. In the Muskoka and Parry Sound regions, great belts, twenty miles or more in length, and from one to five or six miles wide, were burned over, and it is asserted that the smoke of forest fires ascended from every square mile of territory from Lake Nipissing to the Severn. The loss must therefore have been great, and probably quite equal to that in the Ottawa district. Some are inclined to place the amount of loss over this wide stretch of country at only 1,000,000 dols., but that estimate is doubtless much too small, and may be even four or five times below the actual damage. The total loss over the entire province is roughly estimated at from 10,000,000 dols. to 15,000,000 dols.

The great endeavour will now be to cut the scorched timber and get it into the water before the borer begins its work. Much may be saved in this way, or much may be lost by delay.

This has not been an entirely exceptional year as regards forest fires in the Dominion. Nearly, and perhaps every year, there is a heavy loss. The surveys of the new townships of Bonfield and Boulter reveal a condition of their forest lands which is common almost everywhere, from Georgian Bay to the Ottawa. Two-thirds of Bonfield was burned over at one time, and a portion within recent years, while one-third of the forests of Boulton has been swept away. The same story is told of all other parts of the pine country by the surveyors who have traversed them.

Taking into consideration the destructive effect of forest fires, and the settlement of the new lands for farming purposes, it is feared that in twenty years the lumber business of Canada will be a thing of the past. Already only the limited tract along the west side of the Ottawa, it is asserted, from Mattawan to Lake Temiscamingue, the wilderness, rapidly diminishing in area, that lies between the County of Peterborough and Lake Nipissing, and a portion of the north shore district, are unbroken by settlement. Half of this area contains no pine of commercial value. Under the present system of waste, one of the leading industries of the country will be crippled by its competition with districts more favoured by abundance and

easy access. For this reason, those interested in preserving the forests of the Dominion are calling for legal protection of the standing timber.—*Ibid.*

By Circular Resolution of Government the age of entry of candidates for the Forest School who are non-commissioned officers of the native army has been raised to 30.

We wish the authorities would improve the half-yearly list of Forest Officers and make it of some use. It would not much matter if they omitted the list of Forest Rangers, but it is a great pity that the old plan of giving the divisions and the officers posted to them has been given up. There was also in former years a useful general list, giving the order in which Forest Officers joined the department and the period of their service counting for pension. This information is not now given; all we have is the bare list by provinces. Formerly we used to publish in this journal a copy of the list, but at present it is so uninteresting that we have discontinued the practice. We should be glad, however, to publish an annual list giving the stations of officers, the divisions, ranges, etc., if we could manage to get the information together and Government does not meanwhile alter the list.

A Departmental List, to be really useful, should be like the Civil List, having first of all the names of officers in their general order, with their date of entry of the department, present appointments, permanent and officiating, and service counting for pension. Then should come the provincial lists separately, and last should be the list of Circles, Divisions and Ranges, and the officers appointed to them, omitting the rather doubtfully accurate statistics which used to encumber the old lists. If this were done we should know something of what is going on. As it is an officer in one province who wants to find out where his old chums in others are serving, cannot do so. Nor can he learn how other circles and divisions are divided and officered.

The Buffalo Lumber World says there are about 3,000,000 acres of excellent pine lands in Louisiana, which are beginning to attract northern attention. These lands are offered at 1·25 dols. per acre. These southern lands will come into active demand much sooner than is expected, should the enormous requirements of lumber continue.—*Timber Trades Journal.*

Joaquin Miller has solved the forest fire question, says the *Lumberman*. Miller says that to prevent forest fires that kill and destroy it is only necessary to burn over the ground in forests each year, thus destroying any rubbish that may remain

on the ground. Such annual burnings, he alleges, would be so slight in effect as not even to destroy the tenderest green shrub, but at the same time would prevent the accumulation of the branches from the trees, leaves, dead briars, &c., and thus would make a great forest fire impossible. If our guileless poet should happen to get caught in the pine woods of Michigan where such an experiment was being tried, there would be one green thing that would perish, for a fact.—*Ibid.*

ÆSTHETIC taste has been of indirect benefit to the poor Bengali ryot in this way. In the United States, where Oscar Wilde is now wandering, one form of æstheticism is developed in a passion, a consummate yearning, to have every particle of furniture, as far as possible, made of bamboo. The result is that a considerable demand for bamboos has sprung up in the States, and this demand, to a great extent, is met by exports of prepared bamboos from Calcutta. The bamboo stems exported are brought into Calcutta by ryots living in the districts to the south, towards the Sunderbunds, and also from the direction of Midnapore. The sticks when first purchased are merely smoothed by the cutters. The skin of the stem must be as perfect as possible, and worm-eaten bamboos are rejected. After purchase by the exporter, the stems are cleaned and then covered with a mixture of turpentine and cocoanut oil, to preserve them from the action of damp sea air or salt water; they are tied into bundles of fifties, and shipped by sailing vessels to New York or Boston.—*Pioneer.*

ROOTS OF AVICENNIA.—At a recent Meeting of the Roya, Society, Professor Dickson read a paper by Dr. Joseph Bancroft on respiration in the roots of certain shore plants. His observations referred chiefly to the remarkable rootlets of *Avicennia*. These rootlets grow vertically upwards from the larger roots which extend themselves horizontally in the mud of salt-water creeks. The mud bank around the stem is covered by a brush *of such rootlets to a distance of from four to six yards from* the bole of the tree. This brush, by entangling *debris*, protects the bank from destruction by stream or tide. The rootlets are studded with pits or pores emitting powdery matter which consists of cells, and which may be observed floating on the surface of the brackish water of the creek. These pores he regards as corresponding to lenticels, and he finds that when air is forced into the cut end of a rootlet, it issues by the pores. Hence he conjectures that the function of the pores is to contribute to the aeration of the plant—a view coinciding with that held by several botanists as to the lenticels, which they regard as structures affording, like stomata, a communication between the atmosphere and the interior of the plant.—*Nature.*

ATTENTION has recently been drawn to the commercial value of the Quillaia Tree (*Quillaya saponaria*), a native of Chile, the bark of which has been known for a considerable time both in this country and on the Continent, for the saponaceous principle which it contains. In consequence of the trees having been cut down to obtain the bark there is much reason to fear that the supply may fail, particularly if the demand increases. Quillaia bark, it seems, is very extensively used by wool and silk manufacturers both in this country and in France, in consequence of its efficacy as a powerful cleansing agent. Our contemporary, the *Colonies and India*, in drawing attention to this tree, remarks "that a decoction prepared by placing a small piece of this bark, and soaking it overnight in water, will remove in a minute or two grease from articles of clothing and leave the cloth clean and fresh as if it was new. It may also be used for cleaning hair-brushes and other similar purposes, under conditions in which soap and other alkalies are powerless. It is also suitable for a hair-wash, and is said to be largely used by French hair-dressers, though the mode of preparation is kept secret. Such a tree ought to be invaluable in Australia, New Zealand, Cape Colony, and other colonies where wool-growing is a staple industry." Among the uses to which this bark is put may be mentioned that of a preparation for giving an artificial froth or head to ales, a very small quantity put into beer that has become dead causing it to be covered with froth. The bark occurs in commerce in two forms, that of irregular pieces as taken from the tree, and in the form of powder.—*Nature.*

THE following letter occurs in the *Asian* of March 28th, on the subject of the spontaneous ignition of jungle fires:—

DEAR SIR,—During a recent shooting trip in the south of this (Mirzapore) district, I happened to witness a very destructive jungle fire. The jungle in question lay along the side of one of the Kaimur hills, and was principally composed of bamboos.

Sitting that evening by the camp fire, and talking the matter over with my shikaries, they assured me that a very large proportion of these jungle conflagrations are originated by simple friction, caused by wind between dry branches and bamboos.

The explanation struck me as being very plausible, and I should like extremely to know if the experience of your jungle-haunting correspondents leads them to accept the above theory.—C. PERCY HENDERSON.
CAMARHAH, MIRZAPORE, 20*th March* 1882.

We do not ourselves think it possible that the mere rubbing together of bamboos in a strong wind can possibly produce fire: for, be the bamboos ever so dry, and the wind ever so strong, sufficient friction, and consequently sufficient heat, could scarcely be generated. To any one who has seen the labour involved in the production of fire by friction, as practised by jungle tribes, where a cessation of rubbing for an instant only is

generally enough to spoil the process, the idea of fire being produced even by two very dry stems of bamboo seems absurd, and we do not ourselves believe it possible. We believe no jungle fire ever arises except by being lit by some one purposely or accidentally—the only way in which possibly fire could light itself being by the generation of spontaneous combustion in closely packed dry grass. But the idea is, as Mr. Henderson says, a common one among natives and even some Europeans, and we should be glad if our readers could give any opinions they have on the subject, and any evidence they can shew for the foundation of the native belief.

We see that the Agri-Horticultural Society are advocating that the Punjab Forest Department should cultivate the Tree Cotton (*Gossypium arboreum*) at Changa-Manga. The following extract will show their proposals :—

I would suggest the "Changa-Manga" Fuel Plantation as a good locality for forming a Government Cotton Tree Plantation and Nursery for the distribution of plants to all applicants.

The seeds sown in beds would soon yield an ample supply of seedlings, and these, when sufficiently advanced, could be planted out in all directions, where space could be found between growing trees. The transplanting operations, if carried out during the rains, would meet with success, and thereafter the plants would soon be able to take care of themselves, for this cotton, being a sun-plant, will not need irrigation after being once fairly established, and as it will bear cotton wool pods within twelve months, and yield them for nine months out of the twelve, and do so year by year for twenty years, everything is in favor of its introduction. As "*kunker*," which will yield lime, (chunam), when burned, is procurable in most parts of the Punjab, it should be used as a mineral manure for the *Gossypium arboreum* seedlings. The "kunker" should be reduced to coarse powder (without being calcined), and two seers of it should be mixed with the soil, excavated for putting down a seed ing. Thus one maund of "*kunker*" powder would be needed for every twenty *Gossypium arboreum* seedlings, and this manuring should keep the tree well supplied with carbon for at least ten years, when a fresh supply might be applied and dug in. The yield of cotton wool would very soon cover all outlay for preparing the excavations for seedlings and "kunker" manuring, and thereafter 75 per cent. of the produce might be put down to profit, and 25 to cost of collection, packing, cleaning, and transit. As the plantation is preserved, and is well stocked with game, hares may be present in numbers, and if so, thorn bushes will have to be put around each seedling till sufficiently grown. This will keep off deer and antelope as well.

I do not think the Officers of the Forest Department would object to the introduction of the *G. arboreum*, and it would go far to make the Fuel Plantations more than self-supporting. I would recommend the utilization of convict labour for digging the holes, and pounding the "kunker," so that the actual outlay would be very trifling.

It would doubtless be a good thing to introduce the cultivation of such a plant as the Tree Cotton, but people should remember that Government has its regular experimental departments whose business it is to try such things, and that timber and not cotton is the first object of the plantations made by the Forest Department. We note that the quality of the cotton is not mentioned.

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Sandal-planting in Mysore.

LOOKING at planting in its two aspects,—of the production of strong healthy nursery plants, and of getting these planted out so that there shall be no interruption of growth,—sandal-planting is not an easy operation. The seed, a ball of soft, sticky, albumen, the size of a pea, in a fleshy fermentible pericarp, is very liable to go bad; but in ordinary soil it germinates with difficulty, so much so that it was supposed at first that the seed required, as in nature, to pass through the intestines of birds or animals; but here it was overlooked that a bird's gizzard would be certainly destructive to the seed, and the digestion of animals most probably so, while it is a matter of observation that sandal comes up naturally in many places where there are no animals to help it. It is a fact that soaking the seed for one or two days in a mixture of cow-dung and water has been found to hasten germination; but this is observable in other seeds. The difficulty of getting sandal to germinate in the early days of forestry may be put down to bad seed and ignorance of the way to sow it.

As soon as the young sandal has come up its troubles begin: at first, during the rains, with a species of rot in which the root may be observed attacked by a fungoid looking growth. The leaves turn yellow and drop off from below upwards, and the sandal seedling appears as a little stick with only the terminal bud left. If the attack is mild the plant makes fresh root growth, and the terminal bud new leaves; but if not attended to, plants perish very rapidly in this way. I have seen a nursery of 20,000 seedlings destroyed in ten days during heavy rain. The remedy is drainage. The foresters, as soon as the disease appears, "lift" the tile-pots, taking them out of the beds and standing them on one side, high and dry, with the air playing round the pots. When the heavy rain is past the tile-pots go back into the beds.

During the monsoon, to some extent, but more usually afterwards, many plants are lost from grubs eating the fleshy

cellular portion of the tap-root. Sandal has a tap-root like a miniature radish, and it is attacked in the same manner as that and other fleshy roots.

These dangers past, it was observed in the early nurseries that something was wrong during the dry season. Here and there was a plant growing *à merveille*. One thought with horror of its tap-root for the next planting season. Elsewhere, in odd corners, a few plants pushed on steadily: the generality looked pinched and miserable, in different soils, variously manured, and properly watered. When the planting season arrived there was a small proportion of good plants left; and yet, was it not worth planting sandal even on these terms?

The remedy for bad germinations and subsequent poor growth in the nurseries has been found in humus, or the nearest thing to it, in the way of a vegetable manure, which the climate produces. The seed is sown on the tile-pot beds just covered with a mixture of sand and leaf manure. From then, till the plants are transplanted, a year afterwards, the beds are kept constantly *covered* with old leaves, dead grass, or any litter at hand. The leaves and litter, if properly watered, decay rapidly and require to be replenished at intervals of a few weeks. Last year this plan was tried in a few nurseries, and gave good results where persistently carried out. But it raised opposition;—to the careless it gave trouble, to the neat it looked very like a messy craze. During the present season it has been followed in 17 nurseries, in different hands and in different parts of the country. It is easy to account for its beneficial effect: as a matter of observation it leaves nothing to be desired in the appearance of the nurseries. The portion of each nursery under sandal is shaded with boughs so as to afford a broken half-shade similar to that in which sandal comes up naturally in thickets and hedges. Each tile-pot now contains a bunch of fine plants with the rich dark foliage of healthy sandal. There are this hot weather (1881) above a lac of tile-pots stocked with sandal, and in many nurseries it would be difficult to find an empty pot.

Let us pass now to the planting out and management of the tap-root. In young plants the tap-root is usually longer than the height of the plant above ground. It is very sensitive to injury, and this was the cause of the failure of the early attempts to plant sandal. If cut so as to only remove two or three inches, *leaving ten inches above perfectly undisturbed in its pot*, the plant will usually die. The plan now adopted to keep the tap-root of manageable size is to have a layer of bits of broken tile strewn so as to lie flat at the bottom of the tile-pots, much as one pots plants in a flower-pot, and doing so may be presumed to afford the same advantages in the way of drainage. By this means the tap-root is stopped growing down more than ten inches, the depth of the tile-pots; it divides and accommo-

dates itself within the tile-pot; lateral roots develop, and we obtain a form of root suitable for planting.

Transplanting begins as soon as the ground is thoroughly moistened by the first rains: it takes usually about ten inches of rainfall to do this. The tile-pots are lifted, walked away to the newly filled pits. One tile is gently removed and the cylinder of earth and root resting on the other tile slipped into the ground. The earth is filled in, and the remaining tile, gently pushed back from the roots it has protected and confined during the last year, is pulled out, and goes back with the return coolies to the nursery to be re-set, and begin its work again. Watering should be stopped in the nursery a day or two before the tile-pots are taken out, so that the earth cylinders may be as hard as possible, and the transplanting rules provide for a little watering, for a day or two after the plants are put out. It is worth noting that the best planting—the minimum of root disturbance—is during the driest weather (for the season)—a curious adaptation to the weak point of the climate.

Some one may ask why not use flower-pots instead of tile-pots. In the first place flower-pots are more expensive—all potters cannot make them; and, secondly, many of the advantages of tile-pot nurseries would be lost, *i.e.*, the shape of the tile-pot cylinders giving roots with the maximum of depth and the minimum of width—the compactness of the nurseries and consequent saving of water for each bed is a honeycomb of 100 tile-pots in a space of 50 inches × 50 inches—the ease with which the tiles can be removed from the cylinders of earth and used again in the nursery next year. The system of planting from tile-pots has been already described in the pages of this journal. In Mysore, during the past season, two and a half lacs of plants were put out from tile-pots at a saving of fifteen rupees per 1,000 plants. Of this, 5,000 odd was sandal, and the percentage of hot weather failures among the sandal was 35 per cent. It must be remembered that this was the first year of sandal-planting on a large scale, and this figure will probably be much reduced in the future. As usual, nothing was spent on watering or weeding after the plants were put out. Repeated failure is not a very serious matter on these terms; Rs. 5-8 per 1,000 plants represents the cost.

Each tile-pot contains usually more than one sandal plant, sometimes as many as half a dozen, depending on how the seed comes up.

There is thus a survival of the fittest for rot, grubs, and the first hot weather to work on; and then, when space is required for growth with the first monsoon after planting out, all but the best plants in each pit are cut out.

A word in conclusion about sandal plantations elsewhere. We have heard about those of Madras, and would be glad to

learn more: their forest reports always late, have latterly not been sent to Mysore. It is believed that the plantation on the Neilgherries cost considerably more than Rs. 30 per acre of 500 plants, and that that near the Cauvery falls is really *in situ* sowing with a suggestion of English ploughs and elephants—costly enough, and impossible for work among hills or in existing forests. Rs. 30 per acre of 500 plants is now the maximum cost of planting in Mysore, but it is hoped that sandal may do with pits 2 feet instead of 3 feet cube, and then the cost of planting will fall to *Rs. 16 per acre of 500 plants.*

Sandal-planting has been begun, I believe, in the Nizam's Dominions and in the Central Provinces, to both of which places seed has been sent from Mysore. There are some sandal plants now growing in the Botanical Gardens, Brisbane, from Mysore seed. Possibly the existence of frost may mark the northern limit at which sandal can be profitably grown in India. A specimen of sandal from the Nizam's Dominions, compared with Mysore wood, showed a denser structure, and was nearly scentless, but no particulars of the elevation at which it was grown were received. Probably good sandal could be grown anywhere in Southern India between 1,500 feet and 5,000 feet elevation, and a moderate rainfall. The higher limit would be approximately the climate of Brisbane: below the lower in Mysore, the tree looks straggling and forced, but it does not lose its scent. There is now in the Bangalore Museum a specimen fully scented, which was found growing on the banks of the Cauvery at only 1,200 feet elevation. There is a large trade in sandal between Polynesia and China, which began about 44* years ago. The people of *Western Australia find it pays them better to export sandal* at £7 a ton than to till the ground, and the sandal trade has been credited with atrocities in the Southern Ocean and with the present backward state of Western Australia. This wood, however, is inferior stuff. Indian sandal stands as far above all other kinds in the China market as does Indian opium. It is stated that the profits of the middlemen are enormous, and that £200 a ton is a common price for first class Indian wood in China. Be this as it may, is there any other wood in the world which will fetch a *steady nett* price at the place of production of £45 a ton?

KAD-HANDI.

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* Forty years ago the sandal wood trade reached a development which is accounted for by the high value attached to this wood by the Chinese. Speculators fitted out ships and cut down the forests of the Melanesian Islands. The natives naturally resisted this devastation. They were answered by the rifle. In 1842 the crews of two English vessels landed at Sandwich Islands, one of the most luxuriant in the Archipelago of the New Hebrides. The Islanders, when resisting the destruction of their woods, were set upon by the whites, who killed twenty-six, and driving a great number into a cave, suffocated them with smoke till not one remained.

Report on the Forests of Mauritius.

By R. Thompson, *Deputy Conservator of Forests.*

(*Concluded from Vol. VI., p. 316.*)

Part III.—Recommendations and Conclusion.

Preliminary remarks.

In offering these remarks, it is desirable to point out that I have had already the very great advantage of having discussed personally with His Excellency the Governor on the measures which we now recommend, and which, after due reflection and consideration of all circumstances bearing on them, appear to be called for in the interests of Forest Conservancy, and the maintenance of water-supply of Mauritius.

Recommendation claiming early attention.

The measures recommended are therefore as follows:—

1.—Preventing the felling of private forests, and also the clearing of such forest lands for cultivation, or for any other purpose. The same to be effected either by actual purchase of the properties by the Government, or by Law.

2.—The purchase of about 1,800 acres of land for immediate planting with forest trees, at and above Curepipe, and along the sources of the principal affluents of Grand River, North-west.

3.—The survey and demarcation of Crown lands, which are still undetermined; and the preparation of good and reliable maps, on the scale of 1,000 feet to the inch, of all such public lands.

4.—Lowering either by purchase of the land, or by proclamation under the existing law, the mountain reserve lines.

5.—The formation of a department, in the general administration of the colony, to be called the Forest Department of Mauritius, to take charge of and administer to all Crown lands, advise the owners of private forests, and to assume the guardianship of all river and mountain reserves.

6.—Where sufficient protection at present is not afforded to rivers, streams and rivulets by existing borders of trees, the said borders to be widened by the authority of a slight alteration in the existing law.

7.—The formation of two or more blocks of forests in the lower parts of the Island, of about ten thousand acres, to serve as reserves for the supply of fuel and small building wood for the inhabitants residing in their vicinity and in Port Louis.

8.—The Forest Ranger Force to be relieved of a considerable portion of their present duties by the Police Force taking part in them, as directed by Ordinance No. 18 of 1874 and Ordinance No. 13 of 1875. Such arrangement will then allow of Forest Rangers attending to professional duties without any increase to the present force.

The immediate collection of a large quantity of seed of various indigenous forest trees and shrubs, with the view of sowing the same in horizontal contouring bands, on the denuded hills of Port Louis, and other similar localities.

Grounds on which the above recommendations are made.

We will now proceed to discuss the grounds on which the foregoing recommendations are offered:

Recommendation I.—Purchase of private forests.

The Crown forests lie chiefly on the slopes of mountains which are very nearly outside the central parts of the Island, and from the table land of which rise all the principal rivers of the colony. With the exception of the blocks known as Grand Bassin and the Piton du Milieu, all the other Crown lands, covered with trees, cannot afford any protection to the water-supply of the Island; and since the present recommendation is offerded chiefly in the interests of the maintenance of such water-supply, it is evident that, unless measures are adopted for preventing the rapid disappearance of the private forest—seven such as they are—the perennial springs, which feed the rivers, will likewise disappear, or the quantity of water which they now yield will become much lessened. It is notorious everywhere on this Island, that with the disappearance of the forests the perennial springs have either completely disappeared or are considerably diminished in volume; and rivers and streams which formerly never ran dry, are now, during the dried months of the year, mere stagnant pools, if not altogether dried up. This, therefore, is a question which must be considered quite apart from the general bearings of the question of maintenance of forests for their required yield. Nevertheless it is obvious that the existing Crown forests, from various reasons given in this report, are not in a position, even when they will have been brought to their highest state of productiveness, to supply all the future wants of the inhabitants of the Island in fuel, building wood and other forest products; so that it becomes necessary on this ground, likewise, as well as on the other question of the maintenance of water-supply, to add considerably to the area of existing Crown forests, by purchasing some of the private forests, which, by their situation and the promise which they give of becoming, under competent management, valuable State properties, are desirable. However there will of necessity be some exceptions to this, where existing private forests will have to be protected, though they are of no value, present or future, except as affording shelter to springs and rivers. Any money, therefore, spent on the purchase of such properties must be rightly put down and considered as so much capital outlay made for the general public good, apart from the question of any revenue to be derived from such investment hereafter.

The central ridge and watershed of the Island to be brought under forests.

The whole of the central ridge of the table land of the Island, and which is the great watershed in which all the larger rivers take their rise, requires to be permanently retained under forests. The purchase of a large portion of the private forests, which at the present day lie along the south, south-east, and eastern parts of this watershed, will effect this purpose to some extent in those directions. The area that will have to be purchased to effect this will amount to about 30,000 or 35,000 acres out of an available area of some 40,000 arpents. Details of those lands, recommended for purchase, will be found in the Schedule appended to this report. Some of the details have been obtained from Mr. Cantley's memorandum, previously referred to.

These private forests, as will have already appeared, are in a state of more or less dilapidation as regards the older trees, but there is a young and somewhat promising growth which is coming up in all of them, composed chiefly of species which are not indigenous, but which will nevertheless, for some time yet to come, afford all the necessary protection to spring and rivers. The future management of these properties, after they will have been acquired by the Government, will of course be carried out on the same principles, and guided by rules similar to those laid down for the treatment of Crown forest lands; so that a repetition herein is not required.

Private forests to be protected.

Under no consideration ought present owners of private forests to be permitted to fell for timber for firewood or for charcoal (except it be for the extraction of dead wood alone) or for the cultivation of the sugarcane or of any other agricultural crop, in such parts of the Island as it is absolutely necessary to protect for the maintenance of the water-supply. Of course all such preventions by the State being fully indemnified to the owners, who have full rights to do as they like with their own, provided the Government cannot immediately buy up such forests.

Otherwise their disappearance is certain.

We are probably not far wrong when we say that at the present day there are few proprietors of forest lands who have not leased them out to firewood sellers, charcoal burners, and timber merchants. The charcoal burners are undoubtedly the most destructive agents, next to the sugar planter, in the work of demolition now going on with the fullest activity; and which has been in full swing for several years past, and which is about to end, unless the Crown step in and save them, in the disappearance of the remaining private forests from the Island. The charcoal burners, like the cultivators of the soil, proceed by digging up the stumps and roots

and utilizing them; so that any hope of a future young forest coming up, as coppice growth, is entirely checked.

Probable effects of protection.

Protection is what is most needed for the forests of Mauritius, and that protection it is not possible they can ever get so long as they remain at the will and mercy of private owners. *Nature is so prolific in these climates that, given* the necessary protection, even denuded lands will speedily reclothe themselves with tree growths, without any aid from artificial planting; and though such spontaneous growths may be of little value as marketable material, will nevertheless, by keeping the soil covered and shaded, preserve it from drying up, enrich it by the annual deposit of leaves, bark, dead twigs, &c., which go to form the *humus* of a forest soil; and at the same time maintain the land in a condition fit to receive the more valuable species whenever the introduction of such may be desired.

First important step towards Forest Conservancy.

From what has been said it must appear that the first important step required to be taken towards bringing forest matters in the colony to a more satisfactory stage, lies in that important one of saving, from further destruction and consequent extinction, the existing forest growths which at present are in private hands. Such forests, or the greater part of them at least may become, in the hands of government, valuable State properties, which will not only yield in the future returns in direct revenues, but likewise be perpetual sources from which to draw the timber and fuel necessary for the use, comfort, and well-being of the people of Mauritius. And at the same time these woodlands will preserve the moisture they receive in the shape of rainfall wherewith to feed the springs and rivers rising within them.

A large portion of the land must be kept under forest.

The physical condition of the soil of the Island is such that it requires protection, not only from the sun but likewise from the direct action of the comparatively dry strong south-easterly winds which blow over it during the greater part of the year. The soil, the surface of which is thickly strewn with large boulders of rock, parts easily with its moisture; for it is of an exceedingly porous nature, and is far from being of any great depth, except perhaps in a few localities; but its fertility is great when so long as it is maintained in a comparatively moist condition. This moisture it is capable of absorbing directly from the air, unless previously deprived of the organic substances which abound in it, and which air in and around woods is saturated with humidity to a much greater extent than elsewhere, except that perhaps over the sea; hence the importance of keeping under forest as large an area of the land, in

the interior of the Island, as can be afforded, without unduly encroaching on the cultivation of the sugarcane. Even as much as 20 per cent of the total area retained permanently under wood is not too much for a soil like that of Mauritius; that is including all present Crown lands, river and mountain reserves, both private and Crown, and such private forests as are herein recommended to be purchased and added thereto, all of which would then amount to as follows :—

Crown lands determined and otherwise ...	35,000 acres.
Private forest lands purchased in centre of Island ...	35,000 „
Private forest lands purchased in lower parts of Island	10,000 „
Private forest lands now occupied as mountain and river reserves, estimated at	10,200 „
Total	90,200 acres,

equal to 141 square miles, or 20 per cent of the area of the Island. At the present day about 27 or 28 per cent only of the total lands of Mauritius are occupied with the cultivation of the sugarcane.

In European countries the proportion woodlands bear to total areas are somewhat as follows :—

France	17	per cent.
Belgium	18½	„
Germany	26⅓	„
Russia	31	„
Spain	5½	„
Great Britain	5	„

while in Norway and Sweden they are 66 and 60 per cent respectively.

II.—Purchase of 1,800 acres of land for immediate planting.

It is recommended that 1,800 acres of land should be purchased for immediate planting; part of this land is at present under scrub growth, and part under sugarcane cultivation.

The object of this suggestion is to give immediate protection to the sources of the springs and rivers which take their rise in the tract of land above Curepipe, and also to protect the hill sides and natural basins from which rise the principal feeders of the affluents of Grand River North-west. At present these tracts are denuded of forest growth, and more especially is this the case with regard to the basins which feed the River Terre Rouge and de la Cascade, and which are now planted with canes, after the marshes, which formerly fed the springs, had been drained. In a case recently observed, a marsh had been drained from one river system into that of another carrying its waters in the opposite direction.

Action of forests on the rainfall.

Forests and forest soil conserve the rainfall by holding the moisture in mechanical suspension, preventing loss of it by evaporation, but giving it off in even quantities to the

springs which go to feed the rivers. This action of forests is, of course, in proportion to the area covered by them, the larger that is the greater will be the quantity of rain water received, stored, and prevented from being hurried off to the sea, or again given back to the air by evaporation, after having been precipitated.

To give full play to these conservative principles, it is not only requisite that the woods occupy a considerable area, but likewise that their situation be such as to occupy and cover the largest possible space in the natural catchment basins of the various river systems, which are usually situated in regions where the annual rainfall is greatest; for example, here in Mauritius, such regions lie on the slopes of the median ridge of this Island, and which is the natural watershed of the rivers which take their rise there.

Present proposals limited, but nevertheless whole median ridge should be rewooded as opportunities occur.

For the present the proposal for rewooding is limited to 1,800 acres in localities most needing protection, because the enormous price which land has acquired in this colony in such localities makes any larger present proposal prohibitive; but it will no less be necessary, hereafter, to rewood the whole of the central ridge as opportunities for so doing occur by the dying out of the sugarcane cultivation on those heights, and as the colony can afford the necessary expense.

The proposal to rewood 1,800 acres will probably occupy, to develop and carry out fully, from three to four years; at the same time it will cost a considerable sum of money in purchasing the land and for planting it. It, therefore, appears unnecessary that any larger proposal than what the colony can well afford to carry out immediately be now offered; but what is required to be done in the future, when the opportunity for doing it has been found, has already, in the preceding remarks, been indicated.

Other advantages which may accrue from rewooding the land.

Although the immediate object in undertaking these works is to regulate and preserve the present water-supply of the rivers named in the scheme, yet if forests are created, growing timber yielding trees of good kinds, they must become valuable properties hereafter, from their position near railways, and in the central part of the Island; and also since they will ultimately be capable of giving an income, by the steady yield of well grown useful timber and other forest products. Probably three-fourths of the land now recommended for purchase is capable of growing timber of a large size, and which could be yielded by both indigenous and such introduced species as are now so well established in Mauritius. However, should other foreign species than tried ones be introduced, it will be as well to remember not to

risk the experiment, except in such small proportion in the general melange as would render a failure inappreciable.

Reforestation certain to succeed.

We all now know that woods can be artificially created in Mauritius, as we have some fine examples of such, produced by the energies, skill, and talents of some private owners, and such officers as Messrs. Horne and Cantley. We also know, from inspection of existing tracts, that large portions of what are now the mountain forests of the Black River District, do not at the present day form any part of the aboriginal forest growths, but rather that they have come into existence since the latter were cut down and otherwise destroyed. These forests of secondary growth are easily recognized from being mainly composed of species foreign to the original flora of the Island, which were introduced some long time back, and which have now become subspontaneous.

Hence we have forests at the present day which have supplanted the old aboriginal growths of centuries, without any care or thought being given to their creation and maintenance: and this fact alone must appear to us all as being a sufficient and satisfactory answer to those who still imagine that forests to replace the primeval ones destroyed, cannot now be produced by the care and forethought of man.

On the contrary we have good grounds for believing that any future efforts in this direction will meet with better, if not equal, success as the past; and that where mere covering of the soil is desired, simple protection of the spontaneous growths is all that is necessary to ensure perfect success.

Lands spontaneously re-wooded.

There are large tracts of land in the lower parts of the Island which have now become completely rewooded by natural means alone. That these woods will ultimately attain the height and growth of forest trees is unquestionable, and they ought, therefore, to be strictly protected by their owners. Every cord of wood that is now being produced spontaneously without any thought, expense, or care, on the part of the owner, is so much interest being accumulated by nature for him to be realized hereafter on the original capital sunk in the purchase of the land.

Why more protection should be encouraged.

To give some idea of how much might be done towards reforesting the Island, without the aid of planting and the expenditure of a single cent towards it and subsequent cultivation, it will be well to contrast with mere protection what it would cost creating a young forest artificially. From figures which have been supplied by Mr. Cantley we see that the cost of getting an acre of land under plantation is £4. The cost of 1,000 acres would, therefore, be £4,000, the annual interest on which, at 5 per cent, would amount to £200, while the

utmost annual charge in protecting 1,000 acres of spontaneous growth, supposing it required two men to watch and guard the young wood at £24 each per annum, would only amount to £48, as against £200 in the other case, and which of course would still require guarding just as much as the spontaneous growth. Proprietors of land, as a body, might do a deal towards *getting up and maintaining extensive woods in the lower parts* of the Island, in localities where sugarcane cultivation, from exhaustion of the soil, has died out by simply arranging to protect *strictly* from injury all spontaneous growths now springing up on their lands. In this way would they not only be benefiting their estates, the soils of which will again be enriched by the annual deposit of leaves on them, but likewise their pockets will be filled by the future sales of wood and fuel; and should any of them hereafter desire to place any portion of their properties permanently under more valuable forests, to be *managed and worked on a rational system, they will find their* lands in a fit condition for it.

III.—Survey and demarcation of Crown lands.

This is a subject that ought no longer to be neglected, for it is one of considerable importance to the government of the Colony, which has a considerable property, or what is presumed to be such, and yet is not able to lay its hands on it, or to say definitely that the lands belong to the Crown. It is believed, from the figures furnished by the Surveyor-General, that upwards of 13,219 arpents at the present day are undetermined, undefined, and otherwise in a state of doubt and uncertainty as to legal ownership.

It is, therefore, of unquestionable importance that these doubts be settled at once; more so when we consider the enormous value land has acquired in Mauritius during the last twenty years. The department, administered by the Surveyor-General, possesses the requisite qualifications to survey and demarcate all the Crown lands now undetermined, and to prepare good and reliable maps for them.

A good map of the Island required.

It is also submitted that a complete set of maps, similar to that of the Grand Basin *Block*, and on the scale 1,000 feet to the inch, be prepared for all forest lands in possession of the Crown, whether such be ordinary forests or mountain and river reserves. Similar maps, of course, will be required for all properties subsequently purchased by the Crown.

It would also be very desirable that a good and trustworthy topographical map of the Island, on the scale of one inch to the mile, be prepared. The existing sheets, or district maps, on that scale are extremely incorrect, both as to topographical details and by the omission of important features of the land. Of the several maps which the forest officer was supplied with, not one was found to represent them correctly, or to agree with

one another in that or any other respect. Such a map as now proposed, on the one-inch scale, will be of extreme value to the forest officer administering the river and mountain reserves; and which could be accepted, as reliable evidence, in contraventions of forest rules brought before Magistrates. At present, there being no such map, forest rangers find great difficulties thrown in their way by not being able to prove localities to the satisfaction of the presiding Magistrates.

IV.—Lowering mountain reserve lines.

It will have been seen, from what has already been said on this subject, why it is desirable that existing mountain reserve lines ought to be lowered. As they exist, they do not effect the object for which they are maintained. The laying down of these lines is a practical question which no amount of theory can ever settle. The lines to maintain mountain reserves at all must be lowered; and in lowering *them the peculiar features, slopes and contours of each* mountain and its off-shoots, will have to be fully considered, and the lines decided for them practically on the spot. We have gone with Mr. Cantley considerably into this matter, and feel confident that he thoroughly understands what is required. The mountain reserve line to be of any use must be a line drawn which shall follow the line of junction of the mountain, or any of its spurs, with the plain below, expressed in words that is what it amounts to.

Existing mountain reserve lines.

Existing mountain reserve lines are found not only half way up the steep and often difficult slopes of the mountains, but in the majority of instances that we have observed the protection those lines were supposed to afford to the woods, which once covered the mountain sides and summits, has in practice had just the opposite effect; because under the Article of Ordinance, No. 13 of 1875, the reserve lines are carried to elevations exceeding those of some of the mountains and their several systems of off-shoots and spurs taken either collectively or individually. The consequence of this has been that proprietors have now cleared hills and spurs of the loftier ranges with impunity; whereas formerly, it is believed under the old law, they would not have dared to advance much above the imaginary line dividing the ascent from the plain below.

Laying down rational lines.

Should the administration see the way to the carrying out of this suggestion, which it can do under the authority conferred by Article 19 of the Code, without having to offer heavy compensations to existing proprietors, many of whom have now valuable sugar plantations extending from the base to almost the summit of the mountains, and who have merely exercised rights conferred on them by the law, then the

work of laying down rational lines in place of existing ones may well be entrusted to the Director of Woods and Forests, under the general supervision of the Surveyor-General.

V.—Formation of a Forest Department.

The necessity requiring this charge in the existing management, is that without a responsible head to plan and execute works based upon the suggestions and recommendations we have the honor of herein submitting, it is not likely that executive officers, who are unduly burdened with other matters, will have either the time or the inclination for such work.

A further reason lies in that for special and important works, which will entail considerable outlays of public money, competent and responsible officers alone should be entrusted. Such a department, as herein proposed, would not add in any way to existing charges on account of establishment—it would merely amount to a reversal of existing arrangements. It would still consist of a Director of Woods and Forests, who is also the head of the Botanical Gardens, as the Executive Officer, but subordinate to the Surveyor-General whom the law has declared the chief forest officer in the Colony.

Under the Director, and receiving their orders direct from him, would be placed the forest rangers and all other officers appointed to the forests. The Director, as practical head of the Department, would be responsible for the care, protection, and management of all Government forests, and including the mountain and river reserves. As forest officer he would be the direct adviser, through the Surveyor-General, on all professional matters connected with the administration and as lying within his peculiar province. He would, of course, at the same time, be directly responsible to the Government of the Colony for the efficient working of his department.

VI.—River reserves.

A very slight alteration in the existing law will effect all that is necessary in this case. Instead of measuring the width of the protecting belt of trees from the waters' edge, it will be necessary to measure it from the top of the escarpment 50, 25 or 10 feet respectively inland from the top of such escarpment as the case may require.

The river reserves are one of the most important institutions in this Colony. Their existence has done much good in maintaining the water-supply in the streams and rivers which they protect, and are therefore worthy of imitation elsewhere.

VII.—Formation of fuel reserves in the lower parts of the Island.

On the tracts which occupy the most desirable positions for these reserves is at present a considerable spontaneous growth of *Tetranthera laurifolia* and other introduced species. These reserves will give protection to the

otherwise rocky and shallow soils which prevail in these localities. Their presence will likewise cool the air and maintain its moisture. They will also provide fuel and small building material for the population inhabiting the lower tracts.

As to the necessity for establishing special fuel reserves at the present time, we may just consider what the possible demands at any future time the Crown forest reserves, excluding mountain and river reserves from the calculation, may be called upon to meet. If the population of the Island were to remain at what it is now, and if it were dependent for its fuel solely on the Government forests, it would then require to meet its annual consumption no less than 8,550,000 cubic feet of firewood, that is estimating the daily consumption of fuel per head of population at 2lbs. and 30lbs. to the cubic foot. To supply fuel to a population of 350,000 inhabitants at the above rate will require the cutting down annually of 4,275 acres of forest at twenty years growth, and yielding on an average 2,000 cubic feet per acre. To maintain this supply it would be necessary to have a forest of 85,000 or 95,000 acres, so as to allow of a twenty years rotation—this of course not calculating the wood burnt as fuel in the manufacture of the 130,000 tons of sugar now being made annually.

We know that at present little or no wood is consumed by sugar factories; and *apropos* to the subject we will quote from information, which has been kindly placed at our disposal by the Honorable E. Icery, Member of the Chamber of Agriculture of Mauritius. In his letter to me Dr. Icery says:—"It is no easy matter to reply in a precise manner to your question relative to the firewood burnt in the factories of Mauritius for a given quantity of sugar manufactured.

"The ordinary fuel used here consists principally of cane-trash (*bagasse*), and the straw which is collected off the fields a few days after the canes have been cut and carried away.

"Firewood is employed only in the factories situated in damp localities during a certain period of the crop; and even in this case it is never the sole fuel used for all purposes of fabrication. It so happens that it serves alone sometimes to heat one boiler, or sometimes to heat one or two furnaces mixed with a certain quantity of *bagasse*. You will understand that under these circumstances it has never been possible to form a correct idea of the quantity of the fuel burnt with regard to the weight of sugar. Should you be satisfied with a simple approximation, I should say that to produce 400.bs. of sugar, one cord of firewood (112 cubic feet) is required when this is the sole fuel used.

"You also ask my opinion upon the value of *bagasse* as a fertilizer for cane crops. When stacked in heaps and properly treated with the addition of certain substances generally

used in the manufacture of manure, *bagasse* will, at the end of eighteen months or two years, produce an excellent manure equally useful in new soils as in those more or less exhausted."

It will thus be seen that the present demand for firewood for the manufacture of sugar is somewhat limited, and that probably all the firewood thus consumed has been produced on estates which also produce sugar. Yet the time cannot be far distant when the exhausted soil will require to be given back those constituents which alone exist in the cane refuse, or *bagasse* as it is termed, and which cannot be supplied by other manures, however valuable as general fertilizers. Even at the present day, supposing that only a hundreth part of the sugar yearly manufactured in Mauritius required firewood solely for its preparation, we have an annual consumption of 7,280 cords of firewood, each cord representing 112 cubic feet, or an annual crop of 438 acres of forest.

The want of fuel hitherto has not been much felt in the Colony, owing simply to the extensive felling operations which have been going on during the past thirty years in the indigenous forests of the Island, and the supplies which the spontaneous growths have hitherto furnished, and which have come up on the abandoned lands in the lower parts of the Island. However, as it is hoped the further felling of the natural forests will now be discontinued, except under organized systems having a specific object in view, namely, that of the maintenance of forests for the general welfare of the community it will be imperative on the Government to make provision, in advance, towards meeting the future probable demands of the people in this direction. With this view the present proposal is offered only as a commencement to the work. There is no question that for some time yet to come the present Crown lands, and the private forests which will no doubt be added to them in accordance with the recommendations herein made, will yield large quantities of fuel by the removal of the dead and diseased trees which must and should give place in the better management of those forests; and hence the demands of the population can easily be met from these sources for some years to come. But the future must likewise be provided for, and preparations begun for that as soon as possible.

The price of land in the lower parts of the Island is at present low; and we, therefore, imagine there will not be much difficulty or expense connected with the purchase of 10,000 acres in the localities indicated.

VIII.—Forest rangers to be relieved of some of their present duties.

The question of utilizing the services of the police for guarding and protecting existing mountain and river reserves has already been discussed. This question is also recommended on the score of economy, since, if it be

carried out, the present staff of forest rangers will suffice for all future extensions, and for forest operations generally.

IX.—The immediate collection of seeds.

This suggestion has also been discussed, and the proposal for, and method of rewooding such mountains as those of Port Louis, Tamarind Mountain and others, situated under like circumstances and now bare of tree vegetation, has also been fully stated.

Other proposals.

We have in Part II of this report recommended the immediate planting up of such lands forming part of the "Pas Géométriques" as are not already under wood. We have likewise detailed the treatment and management requisite for the Crown plantations and Crown forests; and we would now only draw attention to that section of the report.

Artificial planting where necessary.

We have endeavoured, in the preparation of this report, *to show clearly, and to emphasise* the fact as much as possible, that the denuded lands of Mauritius do not require planting so much, as protection of the spontaneous growth coming up everywhere on them; and which, as far as concerns reforesting the land, is all that is now absolutely necessary. The creation and maintenance of forests for their required yield in timber are, however, separate questions which we have endeavoured to deal with in their proper place in this report. By the general reforesting of the land, we mean the protection of all natural growth, and which if so treated will fully protect the soil from deterioration, and when deteriorated, will reinvigorate it, and at the same time conserve the water-supply and add to the general humidity of the air.

Artificial planting or sowing will, therefore, only be necessary under the following circumstances:—

(*a*)—Rewooding already bare hills and plains specially specified in this report;

(*b*)—The creation of plantations of special kinds of trees; and

(*c*)—Restocking the natural forests, when reproduction is *deficient or undesirable, with the more valuable kinds* of timber-yielding species.

In the above three propositions are comprised all the artificial aid nature requires from man so far as the soil and climate of Mauritius are concerned. With the exception of certain localities, already mentioned, there is no part of the Island which would not reforest itself were the necessary protection given to it.

Forest rules.

There is one other point we would refer to before concluding this report, and that is, we were directed to draw up forest rules for the protection and management of the forests of Mauritius. From what has already been cited in this report, it must be appa-

rent that in endeavouring to alter the forest laws of Mauritius, we should be engaging in a purpose as needless as it would be presumptuous, when the intrinsic worth of those laws are considered in relation to the requirements of the Colony. The Forest Ordinances of Mauritius were doubtlessly drawn up by far-seeing and able statesmen, who, thoroughly understanding the subject, produced and carried through those forest laws which will help to maintain the stability of the Island, as regards its agricultural prosperity, in long years yet to come.

APPENDIX G.

Statement of Revenue and Expenditure on account of Forests, &c., from 1875 *to* 1879.

HEADS OF REVENUE	1875.		1876.		1877.		1878.		1879.		TOTAL.	
	Rs	C	Rs.	C	Rs.	C.	Rs. C.		Rs.	C.	Rs.	C.
Permit to cut grass	2,045	..	992	..	924	..	1,148	..	1,751	50	6,860	50
Leases of right of shooting on Crown lands*	...	..	270	50	5,263	75	2,847	10	4,819	40	13,200	75
Sales of firewood	...	...	1,052	62	722	09	3,429	71	2 334	02	7,538	44
Miscellaneous	...	.	1,000	..	25		...		154	51	1,179	51
Timber sold from Concession Dayot ..	..	..	..		10,540	79	.	...	...	.	10,540	79
Sale of poles	...	..	...	..	334	08	...	..	.	.	334	08
	2,045	...	3,315	12	17,815	71	7,424	81	9,059	43	39,660	07

* Impossible to be given, as prior to 1876 the leases of all Crown lands were accounted for by the Public Works Department without giving the details.

HEADS OF EXPENDITURE.												
Salary of Director	1,000	..	1,000		932	22	633	26	1,933	26	5,598	74
Do. of Guardian	1,115	..	1,467	90	1,500	...	1,500		1,500	..	7,082	90
Do. of Forest Rangers	15,063	00	14,817	03	15,085	00	15,345	..	15,464	51	75,774	74
Planting Crown lands in the vicinity of Port Louis	14,738	35	11,480	28	...	..	...	..	...	...	26,219	23
Do. land at Powder Mills and Mare aux Jonc.s	1,670	90	979	60	..	.	1,302	28	936	59	4,888	47
Do. Terrain Quessy	1,324	50	764	36	493	42	470	58	854	87	3,924	73
Introduction of seeds of useful timber trees	...	..	242	25	..	.	...	...	1,000	..	1,242	25
Planting on road sides	...	.	654	12	..		...	..	...		654	12
Rearing trees at Pamplemousses for planting .. .	...	..	...	..	1,437	75	1,249	52	1,307	63	3,994	90
Planting Government Schools premises	...	..	...	.	188	14	167	79	...	..	355	93
Working Concession Dayot ...	...	..	...		2,996	83	1,665	31	...		4,662	14
Planting vacant spaces in Concession Dayot	...	.	...	..	...	..	2,057	..	1,009	77	3,066	77
Uniform for Forest Rangers ..	858	44	1,393		247	17	1,048	93	1,564	79	6,712	33
Propagation of plants at Réduit ...	...		...	..	...	..	...	...	1,857	18	1,857	18
Medical treatment, building of camps for Forest Rangers	.	..	...	..	...	..	1,122	50	1,516	36	2,638	86
TOTAL	35,787	25	32,799	15	23,689	62	27,457	26	28,868	96	1,48 5,5	28

ORDINANCE No. 18 OF 1874.

AN ORDINANCE *enacted by the Officer administering the Government of Mauritius and its Dependencies, with the advice and consent of the Council of Government thereof.*

To make better provisions for the protection and disposal of Crown lands, and also to provide for the powers and duties of forest rangers.

EDWARD NEWTON.

(*20th November* 1874).

WHEREAS it is expedient to make better provision for the protection and disposal of Crown lands, and further to provide for the powers and duties of forest rangers;

BE IT THEREFORE ENACTED by His Honor the Officer administering the Government with the advice and consent of the Council of Government, as follows:—

CHAPTER I.

1.—The Crown lands may be sold at the discretion of the Governor in Executive Council with the following exceptions: (1), "Pas Géométriques"; (2), Mountain Reserves; (3), River Reserves, when those reserves belong to Government.

2.—The breadth of the "Pas Géométriques" is reckoned from the line of the sea shore which is reached by high water at spring tide; this breadth shall never be less than fifty geometrical paces of five French feet each.

The ponds of sea water, the salt water marshes, lakes, bogs and basins, situate wholly or partially upon the "Pas Géométriques," as well as the islets adjacent to the shore and which can be reached on foot at low tides, the creeks at the mouths of rivers, and the mouths of rivers shall be "annexes" of the "Pas Géométriques," and shall not be sold, but such Pas Géométriques as may have become private property by prescription before the "Arrêté" of General Decaen of 5th May 1807, or by grant or conveyance from the Crown are excepted from the operation of this Chapter, unless when and in so far as they may be brought back to the Crown by voluntary cession, or surrender, or the operation of some other provision of this Ordinance.

The boundary line of the "Pas Géométriques" shall be, as far as the locality shall admit, parallel to the lines of the coast, considered as a whole, and without regard to the small irregularities of the same. It shall be the duty of the Surveyor-General to make or cause to be made by some person delegated by him, the plan of such "Pas Géométriques," and for that

purpose he or his delegate shall have power to enter any adjoining private land.

3.—"Pas Géométriques" and "Annexes" may be leased, provided it be a condition of the contract of lease that the tenant shall plant that portion of the "Pas Géométriques" so leased with trees within the period of five years; one-fifth part of the said portion of the "Pas Géométriques" to be planted every successive year from the date of the lease; and also to maintain the trees planted as aforesaid in a proper state of cultivation.

4.—Whenever the Surveyor-General will deem it expedient to survey or cause to be surveyed any portion of the "Pas Géométriques," it shall be lawful for the Procureur-General, on the application of the Surveyor-General, to cause a notice to be served upon any occupier of the portion of the "Pas Géométriques" intended to be surveyed, in order that such occupier should produce his permission of settlement or title deed within a reasonable delay. Such notice shall be served one month at least before the survey actually takes place.

If the person so called upon to produce his permission of settlement or title deed, refuses or neglects, or is unable to do so within the specified time, the Surveyor-General or his delegate shall, after four days notice given to the parties interested of the day of survey, proceed to survey the said portion of the "Pas Géométriques" *ex parte*, and the memorandum of survey signed by the Surveyor-General or his delegate shall, upon production of the notice duly served, and an affidavit that the party summoned to produce his permission of settlement or title deed, has not produced the same within the specified delay, be evidence before all the Courts of this Colony, of the extent of such portion of the "Pas Géométriques:

Provided that within a delay of six months a party who may have been prevented from producing his titles, shall be entitled to claim a new survey at his own expense.

5.—In all leases of portions of the "Pas Géométriques" to be made by the Governor, after the passing of this Ordinance, there shall be inserted a condition that if any transfer of any such lease is made without the express consent in writing of the Governor, the said lease shall be held to be forfeited along with the buildings and plantations existing upon such reserves.

6.—No lease of any portion of the "Pas Géométriques" shall be granted, except after notice published in the Government Gazette and two daily newspapers four weeks before the lease be made, and the owner of the adjoining land shall have the preference over any other person if he be willing to offer the same terms as the applicant for the said lease.

7.—It shall be lawful for all tenants-at-will or temporary grantees of any portion of the "Pas Géométriques," after receiving notice to surrender the same to Government, at the expiry of the temporary grant in the case of grantees, to obtain a lease for a determined period, provided they undertake to plant the said portion of the "Pas Géométriques" with trees, within the period of five years, one-fifth part of the said portion of the "Pas Géométriques" to be planted every successive year from the date of the lease, and also to maintain the trees planted, as aforesaid, in a proper state of cultivation.

8.—Provided that every tenant under a lease containing conditions to plant as aforesaid, and who shall refuse or neglect to comply with the said conditions, shall incur a penalty not exceeding fifty pounds sterling, and five pounds sterling for every acre of land which he was bound to plant for every twelve months. Such person may, in addition to the fine aforesaid, forfeit his lease without indemnity.

Such leases that shall be cancelled on that account shall be cancelled after conviction of the offence, but without any other legal proceeding.

9.—Every lease of any portion of the "Pas Géométriques" shall henceforth contain conditions regulating the right of such lessee to cut down, destroy, or remove trees, and every such lessee who shall cut down, destroy, or remove trees contrary to those conditions, shall be guilty of an offence, and shall incur a penalty not more than twenty pounds sterling for the first offence, and a penalty not less than ten pounds sterling, and not more than fifty pounds sterling for the second, and the like for every subsequent offence, in addition to the value of the trees cut down, destroyed or removed.

Provided also that one of the conditions of such lease shall be that the lessee shall not cut down, destroy, or remove trees that are under twenty years growth, and then no more than one-tenth of such trees every year; and provided also that the ground on which such trees stood shall by such lessee be immediately replanted with trees. All and every breach of such conditions shall be deemed to be an offence, and shall make the offender liable to the penalties in this article enacted.

Nothing herein enacted shall prevent the lessee of such "Pas Géométriques" to thin trees or cause trees to be thinned under the written permission of the Surveyor-General.

10.—It shall be the duty of the Surveyor-General to plant, or cause to be planted by the Crown as soon as the same may be conveniently done, all such portions of the "Pas Géométriques" that may not be leased or are not now granted to private parties, and also such portions that may be forfeited or may otherwise return to the Crown. Provided that whenever the Crown shall have planted or caused to be planted at the expense of

the colonial treasury any portion of the "Pas Géométriques," the Government shall not be bound to grant a lease of the same to any person in preference to any other person.

11.—No portion of any Crown land shall be disposed of by free grant or at any other than its full value as hereinafter provided for, except in the case of land required for religious, charitable or educational purposes.

The Governor may, upon the advice of the Executive Council that the purposes for which the land is required are *bonâ fide* religious, charitable or educational, grant a concession or a lease of such land on payment of a nominal price or rent.

All such grants or leases shall be conditional on the land being or continuing to be applied to the purposes for which the grants or leases have been made.

12.—All sales of Crown land shall be by public auction.

13—All leases of Crown land shall be by public auction or private contract upon such terms and conditions as the Governor shall approve, provided the same be not inconsistent with the provisions of this Ordinance, and the rents for the said lands shall be invariably paid in advance.

14.—Whenever any Crown land shall be intended to be sold by public auction, the Surveyor-General shall give notice of the intended sale if the upset price be under one hundred pounds sterling, in the Government Gazette, and two local newspapers within the week immediately preceding the sale; if the upset price be above one hundred pounds sterling, similar notices shall be given in two consecutive numbers of the Government Gazette, and be twice inserted in two local newspapers within fifteen days immediately preceding the sale. In every case the notice shall state the place of sale, the upset price, the locality and the extent of the lands so intended to be sold.

15.—Should there be upon the land to be disposed of any buildings not belonging to the Crown, such land shall be sold irrespective of the value of such buildings, the purchaser of the land being left free to contract with the owner of such buildings.

Provided that previous to such land being put up for sale, the owner of the buildings shall receive twenty-eight days' notice from the Surveyor-General in order to elect to remove his buildings previous to the sale.

16.—Every sale shall commence with the upset price fixed by the Surveyor-General, and the land shall be adjudged to the highest bidder, provided his offer shall exceed such upset price. It shall be distinctly stated in the notices published as above, whether when there are on the land to be sold buildings likewise belonging to the Crown, the buildings are or are not to be sold with the land.

17.—The conditions of sale settled by the Surveyor-General shall be read aloud by the Vendue Master, and may vary according to the special circumstances of every case, provided that in every case one quarter part of the purchase price be paid down previous to the purchaser being allowed to sign the conditions of sale; and provided also that the purchaser do give his bond and the bond of two securities bound jointly and severally with himself, to pay the balance of the purchase price at the time or times, and in the manner settled in the conditions of sale.

Nothing herein contained will take away, or in any manner modify, the Government privileged vendor's right in and over the property thus sold.

18.—The Vendue Master shall forthwith pay into the hands of the Receiver-General the sums paid down on account of every such sale, and it shall be the duty of the Receiver-General, to whom the necessary information shall forthwith be conveyed by the Surveyor-General, to claim payment of the balance due at the time or times when such payments ought to be effected.

19.—It shall be lawful for the Governor to grant a delay to a purchaser or purchasers for the payment of the balance or balances due on any purchase price; and if any such balance or balances be not paid at the time or times they should be paid, the land shall be put up again for sale by public auction in manner and form as aforesaid. The monies deposited on the day of sale shall be forfeited, and the bonds shall at once be referred to the Procureur-General for action in case of need.

Provided that if on a subsequent sale, or upon action brought against the original purchaser or sureties, the whole amount of the original purchase price, with all costs and incidental charges be recovered, it shall be lawful for the Governor to remit to the original purchaser such portion of the forfeited monies as shall be in excess of the original purchase price, costs, and incidental charges.

20.—A purchaser will be at liberty to pay to the Vendue Master, at the time of the sale, the whole of the purchase money, and also pay by anticipation into the hands of the Receiver-General the whole of the balance due on the purchase price.

21.—Every purchaser or lessee shall be bound to execute the deed of sale or of lease within four months of his entry in possession. Every deed of sale shall embody the conditions of sale under which the adjudication took place, a short memorandum of the adjudication, and to it shall be annexed a descriptive survey of the lands sold, made, or caused to be made by the Surveyor-General if the conditions of sale do not convey a sufficiently clear and accurate verbal description.

The survey shall be made at the expense of the purchaser.

Every deed of lease shall contain the stipulated conditions of the lease, and to it shall likewise be annexed a descriptive survey under the same conditions as are enacted for deeds of sale.

22.—Such deeds, whether of sale or of lease, shall be made at the expense of the purchasers, or lessees, and shall be registered and transcribed by the Conservator of Mortgages at the instance of the Government, but at the expense of the said purchasers or lessees.

Such deeds shall be signed by the party or parties purchasing or taking the lease on the one part and the Surveyor-General on the other.

23.—Should any purchaser or lessee neglect to execute his title deed within the above mentioned delay, he shall receive a notice to do so within fourteen days, and if such notice be not complied with within such fourteen days, the sale or lease shall be held to be annulled, and a new sale or lease proceeded with in manner and form hereinbefore provided for; the monies paid by such purchaser or lessee being forfeited, subject to the power granted to the Governor by Article 19.

24.—Persons desirous of having an opportunity of purchasing at public auction lands which have not been advertized for sale, or of obtaining a lease of the same, may apply to the Governor, stating as precisely as possible the locality, area, and boundaries of the land required to be purchased or to be held under contract of lease.

25.—It shall henceforth not be lawful for the Governor to grant Jouissances, either limited or unlimited, of Crown lands.

26.—Persons holding existing Jouissances for an unlimited period of tenure, shall be required to exchange the same for permanent grants or leases as the Governor shall determine. Such grants or leases being as much as possible in accordance with the terms and conditions of the original Jouissances, and compensation being given to the holder of such Jouissances whenever the original terms and conditions have to be modified to the prejudice of such holder.

27.—When existing Jouissances, now held for a limited period, determine by efflux of time, such Jouissances shall not be renewed, but may be converted into a sale or a lease as the Governor shall deem fit.

28.—Should there be on such lands, held under a Jouissance title for a limited period, buildings erected by the holder of the Jouissance, such holder shall have the right to remove his buildings or to demand that the land be put up for sale in manner and form as hereinbefore enacted, unless the Governor agrees to purchase the said buildings.

29.—All squatters upon Crown lands shall be ejected by the ordinary process of the courts of law. Provided that when the Crown land squatted upon is under the value of fifty pounds sterling, according to the Surveyor General's estimate, if the squatters set up a title to the ownership of such land, the matter shall be referred to a Judge of the Supreme Court in Chambers who shall direct if there be really *bonâ fide* a title, founded upon, whatever may be the ultimate value of the land that the ordinary legal process be resorted to; but if there be no title founded upon, such Judge in Chambers shall order such squatter to remove from such land within such a time as may, to such Judge, seem just and proper, and further direct that if the order be not complied with, such squatter shall be imprisoned for a period of time not exceeding three months.

30.—The reference to the Judge in Chambers shall be summary, and eight days notice thereof by summons given to the squatter at the instance of the Surveyor-General, and by the directions of the Procureur-General, shall be sufficient, provided the service of such summons be personal, or that if the squatter cannot be found, copies of the summons be left at the residence of such squatter.

Should the squatter not appear, and no valid or sufficient reason for his non-appearance be given, the Judge may proceed to grant the order of ejectment by default.

Provided that such squatter shall at any time before ejectment, and within three months after such ejectment, have the right to obtain from the Government a sale or lease of the land squatted upon, unless the same be required for purposes of public usefulness.

Provided he do pay all costs and expenses incurred to eject or attempt to eject him.

31.—All fees hitherto received by public officers on account of grants, sales or leases of Crown lands, are henceforth abolished.

32.—Any public officer, whose vested rights are prejudiced by the abolition of such fees, shall have his legal and equitable claim to compensation investigated and determined.

33.—Whenever any Government surveyor or any sworn land surveyor, deputed by the Surveyor-General, shall, *bonâ fide* in the course of a survey, find it necessary to enter upon the property of a neighbouring proprietor for the purposes of his operations, it shall be lawful for him to do so, provided that if such neighbouring proprietor, to whom eight days' written notice shall have been given, be willing to urge any objections, or to make any protestations as seem to him advisable, such Government surveyor or sworn land surveyor shall be bound to take note of such objections or protestations, and enter the same in the memorandum of survey by him drawn up.

Provided if it be found necessary by the Surveyor to cut standing crops for the purposes of his operation, he shall apply to a Judge in Chambers, and the Judge may give an order to that effect after having heard the said neighbouring proprietor.

34.—Whenever the curator of vacant estates shall have been sent in possession of real property, the area of which shall be of fifty acres or more, he shall give notice of the fact to the Surveyor-General, whose duty it shall then be to keep watch, superintend and protect such real property on behalf and at the expense of the curator of vacant estates.

But the Surveyor-General shall not be at liberty to incur any expense on account of such real property, except such as may be necessary to keep watch, superintend, and protect the same.

35.—The Surveyor-General shall, with the approbation of the Governor, appoint, from time to time, duly qualified persons to act as forest rangers to enforce the execution of the Woods and Forests' Laws of this Colony.

36.—The said forest rangers shall be paid such salaries as may from time to time be fixed by the Governor by and with the advice of the Council of Government.

Every forest ranger shall be sworn before a district or a stipendiary magistrate.

37.—Every forest ranger shall be engaged before the stipendiary magistrate of Port Louis, and no forest ranger shall be engaged for more than two years.

38.—Every forest ranger so engaged, who shall, without authority from the Surveyor-General, abstain from performing his duty, or who shall neglect to perform his duty, or who shall before the term of his engagement resign, without a cause, found to be just by the stipendiary magistrate, shall be deemed guilty of an offence, and shall be condemned by the said stipendiary magistrate to a fine not exceeding twenty pounds sterling, or in case of non-payment to imprisonment not exceeding two months.

The Procureur-General by himself or deputy, and the Surveyor-General by himself or deputy, shall have power to prosecute under this Ordinance.

39.—Every forest ranger found unfit for his duties by the Surveyor-General may at any time be dismissed by the Surveyor-General after one month's warning, or on receipt of one month's wages in advance, and for misconduct, every forest ranger may be fined by the Surveyor-General, provided the fine does not exceed one month's wages, and may even be summarily dismissed on sufficient grounds of misconduct.

All fines awarded under this Article shall be paid into the "Forest Rangers' Reward Fund."

40.—It shall be lawful for the Surveyor-General, at the request of persons owning or occupying woods and forests, to appoint keepers of woods and forests. Such keepers shall

be paid by such owners or occupiers, and they shall have within the limits of the said private woods and forests, the same powers as forest rangers, to assist in enforcing the provisions of this Ordinance, and of all Ordinances relative to woods, forests and rivers and bringing offenders before the competent court.

The name and appointment of every forest ranger, and of every forest keeper shall be duly published in the Government Gazette.

41.—The notification in the Government Gazette of the appointment of any forest ranger or forest keeper shall be sufficient evidence before any court of justice of this Colony of the right of such forest ranger or keeper to enforce the provisions of this Ordinance and to prosecute offenders

Every such ranger or keeper shall be provided by the Surveyor-General with a staff having the Queen's Arms and the words "Woods and Forests" painted thereon, and the exhibition of such staff shall be held to be sufficient notice to all persons who shall be cognizant thereof that the person exhibiting the same is a forest ranger or a keeper of woods and forests and is on duty as such respectively.

42.—All police inspectors, non-commissioned officers and constables of police shall at all times have the same rights and duties as forest rangers and shall be deemed forest rangers under this Ordinance when acting as such.

43.—Every forest ranger, keeper or other person qualified to act as a forest ranger under this Ordinance shall, whilst acting in the exercise of his functions, be deemed a public functionary, provided that the rights of the Surveyor-General of fining or summarily dismissing them as provided in Article 39, and the right of the stipendiary magistrate of punish ng them in the cases provided for in Article 38, be not on that account taken away.

44.—The Laws, Ordinances and Regulations in Schedule A mentioned are hereby repealed.

PASSED in Council, at Port Louis, Island of Mauritius, this seventeenth day of November one thousand eight hundred and seventy-four.

J. KYSHE,
Acting Secretary to the Council of Government.

Published by order of His Honor the Officer Administering the Government.

W. H. MARSH,
Acting Colonial Secretary

SCHEDULE A.

Laws and Regulations repealed.

1*st*—The Arrêté of the 5th May 1807 (Code Decaen No. 144.)

2*nd*.—Ordinance No. 21 of 1856.

3*rd*.—Regulations for the disposal of Crown lands of the 21st June 1864.

4*th*.—All parts of Colonial Laws, Arrêtés, Proclamations, Notices and Ordinances which may be contrary to, or inconsistent with, the provisions of this Ordinance.

ORDINANCE No. 13 OF 1875.

AN ORDINANCE *enacted by the Governor of Mauritius and its Dependencies, with the advice and consent of the Council of Government thereof.*

To make provision for the conservation of woods and forests on the Crown reserves and plantations and forests of the Colony; and also to protect the watercourses of the colony.

A. P. PHAYRE.

(22*nd May* 1875.)

WHEREAS it is expedient to make better provision for the conservation of the woods and forests on the Crown reserves and plantations and forests of the Colony; and also to protect the watercourses of the Colony;

BE IT THEREFORE ENACTED by His Excellency the Governor with the advice and consent of the Council of Government as follows:—

CHAPTER I.

Interpretation of Terms.

1 The following words and expressions in this Ordinance shall have the meanings hereby assigned to them unless there be something in the subject or context repugnant to such construction, that is to say:—

1*st*.—The words "Crown lands" shall include the *Pas Géométriques* and all lands belonging to or in the possession of the Crown, or which may be hereafter acquired by the Crown; and shall also for the purposes of this Ordinance include all lands of which the curator of vacant estates has possession, or has been sent into possession.

2*nd*.—The *Pas Géométriques* shall mean the ground lying on the sea coast of the Island, between high-water mark in spring tides, and a line drawn parallel to the general contour of the coast (without regard to small irregularities or sinuosities thereof) at a distance of two hundred and fifty feet from the said high-water mark:

Ponds of sea water, salt water marshes, lakes, bays and basins, wholly or partially within the said line, small islands adjacent to the shore, banks left dry at low tides, creeks at the mouths of rivers, and the mouths of rivers shall be deemed to be "annexes" of the *Pas Géométriques*:

Provided always that any portion of the *Pas Géométriques* which by prescription prior to 18th May 1807, or by grant or conveyance from the Crown, shall have become private property, and which shall not have been or may not hereafter be re-acquired by the Crown by forfeiture, surrender, purchase or otherwise, shall be exempted from the provisions of this Ordinance, relating to *Pas Géométriques*:

3rd.—The words "mountain reserve line" shall mean a line situated on the side or slope of a mountain or spur thereof having an altitude exceeding that of the base line by one-third of the difference of altitude between that of the ridge line and the base line. A point in the ridge line shall have for its corresponding point in the reserve line a point lying in the same vertical plane as the point to be taken in the base line for the measurement of altitude. The line passing through these three points is to be the one which has least length in the horizontal projection:—

For example:

Ridge line	...	...	...	1,000	feet.
Base line	...	...	...	400	,,
Difference	...	...	...	600	,,
One-third	...	...	...	200	,,

Reserve line 400×200=600 feet above the level of the sea.

The reserve line shall not be a curve line, but shall be composed of a series of straight lines following generally the rheoretic line, but neglecting its smaller sinuosities. Provided always that in the whole no additional area shall be given to the reserves for any one property.

And provided always that the reserve line shall in no case have a less altitude above the base line than two hundred feet.

4th.—The words "Mountain Reserves" shall mean the ground lying on both sides of the ridge line, between it and the reserve line of all mountain ranges comprehended in Schedule A to this Ordinance appended.

5th.—The words "base line" shall mean that of Schedule A to this Ordinance appended. Provided always that nowhere shall a base line have a less altitude than one hundred and fifty feet above mean sea level.

6th.—The words "mountain range" shall include the main chain and all the spurs, and spurs of spurs, pertaining to the system.

7th.—The words "river reserves" shall mean the ground on either side of a stream between the ordinary edge line thereof or as traced out by stones and boulders and a perpendicular let fall, in the case of a river on a line of fifty feet in length, in the case of a rivulet on a line of twenty-five feet

in length, and in the case of a feeder on a line of ten feet in length, projected horizontally to the said edge line.

Provided always that river reserves shall include the whole escarpment of any river, rivulet, or feeder whatever may be the height or area of such escarpment:

Provided also that the line of fifty feet in length may be without permission reduced to thirty feet, and that of twenty-five feet in length be without permission reduced to fifteen feet if the owner or occupier of the river reserves do plant with trees certified to be suitable trees by the Surveyor-General, and maintain and protect such trees at his own expense to such thirty or fifteen feet as the case may be, and have a border of vetivert or other suitable plant at that distance.

8th.—Any marsh or morass situated on Crown lands from which a watercourse flows, shall be held to be part of such watercourse, and shall be under the provisions of this Ordinance.

And it shall be lawful for the Governor in Executive Council to proclaim that such marshes or morasses, as aforesaid, which may be private property, shall form part of the watercourses flowing therefrom, and be placed under the provisions of this Ordinance, subject to compensation to the owners thereof.

9th.—The word "reserves" shall mean and include mountain and river reserves.

10th.—The word "river" shall mean any stream mentioned in Schedule B to this Ordinance appended, or any stream in which fifty cubic feet or more of water per minute usually flows.

11th.—The word "rivulet" shall mean any stream or the affluent of any stream mentioned in Schedule B; or any stream in which less than fifty cubic feet of water, and more than ten cubic feet of water per minute, usually flows.

12th.—The word "feeder" shall mean the affluent of any stream mentioned in Schedule B aforesaid, or any stream in which less than ten cubic feet of water per minute usually flows.

13th.—The word "escarpment" shall mean the bank of any river, rivulet, or feeder, the mean slope of which makes an angle of not more than twenty-six degrees with the vertical line.

14th.—The word "tree" shall mean live timber brushwood, shrubs, underwood, and the branches and twigs thereof respectively.

15th.—The word "wood" shall mean any tree destroyed or removed.

16th.—The word "owner" shall include persons having the full legal ownership of land or other real property, or having the usufruct, or holding under a contract of antichresis, or under a temporary grant or concession, or sequestrators.

17*th*.—The word "occupier" shall mean the lessee of land, and shall include persons having legal possession of real property, although their right of ownership be disputed.

18*th*.—The word "person" shall include owners and occupiers of land, and shall extend to individuals, corporations, companies, societies, partnerships, and communities.

19*th*. The word "destroy" shall mean fell, cut, mutilate, lop, bark, or in any way whatsoever break or damage.

20*th*.—The word "remove" shall mean carry, convey, or take away in any manner whatsoever.

21*st*.—Words in the singular number shall, unless repugnant to the subject or context, include the plural and *vice versa*.

22*nd*.—The word "foot" shall mean the old standard French foot of one-sixth of a toise, being the unit of length in general use in this Island.

CHAPTER II.

Destruction of Timber on Reserves, Plantations, and Forests.

2.—Any person who shall destroy, or cause to be destroyed, or who shall remove, or cause to be removed, any tree on any reserves without having received the written permission of the Surveyor-General so to do, shall be liable, on conviction thereof, in the case of a first offence, to a fine not exceeding ten pounds sterling, and in the case of a second or any subsequent offence, within a period of eighteen months from the date of the preceding offence, to a fine not exceeding fifty pounds sterling, and in every such case to imprisonment for a period not exceeding three months; and shall further, in every case, be condemned to pay a sum equivalent to the value of any tree so destroyed or caused to be destroyed, or removed, or caused to be removed by him.

Provided that every proprietor of river reserves may cut down and destroy brushwood for the purpose of planting useful or ornamental trees, on giving previous notice to the Surveyor-General of his intention to do so, and on condition that if such trees be not planted according to notice, the penalties enacted above shall be held to have been incurred.

It shall further be lawful for every proprietor of river reserves to cut down, destroy and remove live trees or brushwood for the purpose of opening the boundary lines of his property, or building a bridge, or setting up a chaussée, or making a road across any river or rivulet, and also to clear away, cut down, and remove trees and brushwood on a space not exceeding thirty feet in width so as to have convenient access to the river for his cattle.

Provided such spaces be not less than half a mile distant from each other on the same property.

No permission shall be required for the purposes set forth in the preceding paragraph, but notice shall be given to the

Surveyor-General as to the day on which such cutting shall take place at least ten days before the trees are cut down, destroyed, or cleared.

Provided, that if any proprietor cuts down, destroys, clears away or removes trees or brushwood, or causes or suffers the same to be cut down, destroyed, cleared away, or removed, under the false pretence that a bridge is to be built, a chaussée set up, or a road or access for cattle made, such proprietor shall be deemed guilty of an offence, and for every such offence *shall be liable to a fine of fifty pounds sterling or three* months imprisonment.

Provided also that any person who shall plant otherwise than with trees any land comprised within the river reserves aforesaid, except with the permission of the Governor as hereinafter provided, shall incur a penalty at the rate of fifty pounds sterling per acre, and the plantations so made shall be forfeited.

3.—Any person, except the proprietors of the land or persons authorized by them who, without the written permission of the Surveyor-General, shall be found upon any reserves, provided with any axe, hatchet, or other instrument or implement employed for cutting trees, shall, unless he prove to the satisfaction of the magistrate that the said axe, or other aforesaid instrument was intended for some lawful purpose, be liable to a fine of not exceeding five pounds sterling.

4.—Any person who shall destroy, or cause to be destroyed, or who shall remove, or cause to be removed, any tree in any forest or in any plantation of trees belonging to the Crown *without having received the written permission of the Surveyor-*General, or in the case of a private owner without the consent of such private owner of such forest or plantation, shall, on conviction thereof, be liable in the case of a first offence to a fine not exceeding ten pounds sterling, or in the case of a second or any subsequent offence, within a period of eighteen months from the date of the preceding offence, to a fine not exceeding fifty pounds sterling; and in every such case to imprisonment for a period not exceeding two months; and shall *further*, in each case, be condemned to pay to the owner a sum equivalent to the value of any tree so destroyed, or caused to be destroyed, or removed, or caused to be removed.

5.—Any person who either wilfully, or through his own negligence shall, by setting fire to herbs or grass, or by lighting a fire, cause a conflagration by which any tree or plantation of trees not belonging to such person or growing on any reserves shall be destroyed, shall be liable to a fine not exceeding fifty pounds sterling; reserving always to the Procureur-General, should he think fit, the right to prosecute the offender under any other law of the Colony.

6.—It shall be unlawful to plant, or cause to be planted, otherwise than with Jamrosa, Yatis, Bois Lousteau, Bois Noir, Faux Gayac or other suitable trees to be approved by the Surveyor-General, or to cultivate any reserves, except under the shelter of the aforesaid trees, and in the manner prescribed by the Surveyor-General, with a right of appeal to His Excellency the Governor in Executive Council; and every person contravening this provision, shall incur a penalty at the rate of fifty pounds per acre, and proportionally for any part of an acre of land so illegally planted or cultivated. Plantations made, or crops sown in contravention of the terms of this Article shall be forfeited, and belong to Government.

Provided that this Article shall not apply to sugarcanes growing on any reserves at the date when the Ordinance No. 9 of 1872 came into operation; but it shall be unlawful, under the penalties aforesaid, to plant or cultivate any reserves in future, except as provided in the preceding paragraph.

And further provided that the Governor may authorize (subject to such conditions as he may deem advisable) the proprietors of reserves to plant otherwise than with trees such portions of the said reserves, as it may be found inexpedient to plant with trees.

7.—River reserves and other reserves which do not now belong to the Government, are and shall continue to be the property of the owner of the adjacent land unless legally sold, conveyed, or assigned to some other person; and it shall not be lawful for any person or persons to trespass thereon, on any pretence whatsoever, provided that the Surveyor-General and all proper officers shall have a lawful right of entry to carry out, or compel obedience to the provisions of this Ordinance.

8.—Whenever the permission of the Surveyor-General shall be required, either to cut down trees or for any purpose whatsoever, and such permission is refused, it shall be lawful for the applicant to appeal by petition to the Governor in Executive Council, who shall decide upon such appeal.

Provided such appeal be made within one month from the notification of such refusal, and provided that pending the appeal the Surveyor-General's decision be held binding, and that any person or persons doing or causing to be done any act in disregard of such refusal, shall be liable to the penalties in Article 2 enacted.

9.—In any case in which neither the occupier nor the proprietor is known, or in which legal doubts exist, as to the proprietorship of any unoccupied land, the Surveyor-General may, after giving notice of his intention in three consecutive numbers of the Government Gazette, replant such reserved land; and the cost of such plantation shall be a first charge upon such land, and may be recovered in the ordinary course of law.

10.—Whoever shall fish in any part of a river, rivulet, or stream without the consent of one of the riparian proprietors of such river, rivulet or stream shall be guilty of an offence and be liable to imprisonment for a period not exceeding one year.

It shall be no defence to a prosecution under this Ordinance that permission has been obtained from some other proprietor whose riparian rights lie above or below the spot where the offence has been committed.

11.—The Government may plant with trees, unless the proprietor or occupier of the bordering lands elect to do so, within a reasonable delay, all the main road sides within twelve hundred feet above the level of the sea, the distance between such trees not to be less than fifteen feet, and not more than twenty feet, and one row of trees on each side of the road to be sufficient.

Provided that it shall not be lawful for the Government to plant trees within thirty feet of any building, if such plantation be objected to by the owner.

Whoever shall, without the consent of the Surveyor-General, cut, mutilate, lop, bark, or destroy any tree planted on the sides of a main road, shall incur for each tree thus mutilated, lopped, barked or destroyed by him, a penalty not exceeding twenty pounds sterling.

CHAPTER III.

Survey of Mountain Reserves.

12.—The Surveyor-General shall proceed to determine the reserve lines of the different mountain ranges, after having given a written notice to the owners and occupiers of the land on which the said lines are to be fixed at least ten days previous to such operation.

13.—The Surveyor-General shall, as soon as may be, after the reserve lines have been determined, proceed to fix the boundaries of the mountain reserves by means of a survey and plan.

Before making such survey and plan he shall give intimation thereof by a written notice at least ten days previously to such survey.

14.—For the purpose of making such survey and plan, the Surveyor-General, or any person deputed by him, shall be entitled to enter upon and pass through any private property.

15.—The survey and plan of the reserves of any mountain, when completed, shall be forthwith deposited in the Registry of the Supreme Court, and shall be open to the inspection of any person or persons interested therein, during thirty days from the date of a notice to that effect, issued by the Registrar of the Supreme Court, and published in the Government Gazette, and in three daily newspapers of the Colony. Article 14 of Ordinance No. 33 of 1867 shall not apply to any such survey or plan. The Registrar of the Supreme Court, on receipt of

any such survey and plan, shall endorse thereon, the date of receipt by him, and shall affix thereto the seal of the Supreme Court.

16.—Any person, dissatisfied with the reserve line and boundaries of mountain reserves on his property, as fixed and determined aforesaid, may, within the said period of thirty days, appeal by way of petition to the Supreme Court. Such petition shall set forth the reasons of the appeal, and no reasons other than those set forth in the petition shall be entertained by the Court. It shall be competent to the Supreme Court on such appeal as aforesaid, to approve, modify, or alter the boundaries fixed and determined by the said survey or plan as the court may seem just.

17.—The Registrar of the Supreme Court, shall, at the expiry of the said delay, if no appeal shall have been made, or if an appeal shall have been made, so soon as the alterations or modifications, if any, ordered by the Supreme Court shall have been made thereon, deposit the said survey and plan in the Office of the Conservator of Mortgages.

18.—In any complaint, action, or suit, relative to mountain reserves, a copy of any such plan, signed by any sworn land surveyor, shall be received in evidence in lieu of the original plan, unless such copy be proved to be incorrect.

19.—But inasmuch as the above-mentioned detailed survey of such mountains, and proceedings subsequent thereon will require much time and expense, it is hereby enacted that until such detailed survey has been made and been fully approved as hereinbefore enacted, in any complaint for an offence relating to the mountain reserves, the base lines contained and described in Schedule A shall be held to be, for all intents and purposes, the base lines of the mountains to which they respectively refer, and it shall not be lawful for any Court, Judge, or Magistrate to ignore such base lines, or adopt other base lines in order to determine whether or not the *locus in quo* the offence is alleged to have been committed is within the mountain reserves in the sense of this Ordinance.

Provided that, whenever another base line has been, by detailed survey, settled and determined, the Governor shall have the right, by proclamation, to order that such new mountain base line shall, for all intents and purposes, be the statutory base line in lieu and stead of the base line in Schedule A at present contained and described.

CHAPTER IV.

Power to make Regulations.

20.—It shall be lawful for the Governor in Executive Council to make regulations, and from time to time to add to, alter or revoke the same for the purpose of carrying out the provisions of this Ordinance; and such regulations, if they be

not inconsistent with, or repugnant to, the provisions of this Ordinance, shall be submitted to the Council of Government at its earliest meeting, and if not disallowed within one month, have the same force and effect as if they had been contained verbatim herein.

21.—Any breach of such regulations shall be deemed an offence against the provisions of this Ordinance, and any person convicted thereof shall incur a fine not exceeding five pounds sterling for the first offence, and a fine of not less than five pounds and not exceeding ten pounds sterling for every second or subsequent offence, committed within the period of eighteen months from the date of the preceding offence.

22.—It shall be competent to the Governor by regulation to add to Schedule A, by inserting therein the name of any mountain or hill, and also to describe and determine the base line thereof in the manner and for the purposes in Article 19 enacted; and to add to Schedule B by inserting therein the name of any river or rivulet; and any such mountain, hill, or base line aforesaid shall thereafter be deemed to be a mountain or hill or base line, and any such river or rivulet shall thereafter be deemed to be a river or rivulet or feeder within the meaning of this Ordinance in the same manner as if the same had been included in either of the said Schedules respectively.

CHAPTER V.

Provisions for enforcing this Ordinance.

23.—Any person found committing an offence against this Ordinance may be arrested without warrant, by the owner or occupier of the land upon which the offence has been committed, or by any person in the service of or duly authorized by such owner or occupier or by any forest ranger, police officer or constable, unless he be known to the person making the arrest, or give satisfactory information or reference with respect to his name and place of residence.

24.—Any person apprehended under the provisions of the preceding Article shall immediately be taken before the officer in charge of the most readily accessible police station, who shall release such person so soon as he shall have satisfied himself with respect to the name and place of abode of the said person, or so soon as sufficient personal bail shall have been given for his appearance.

25.—If such person be not forthwith released, he shall as speedily as possible, and at latest within forty-eight hours after his apprehension, be brought before the magistrate of the district where the offence is alleged to have been committed.

26.—Any cattle, vehicles, implements, tools, or wood found in the possession of any person contravening the provisions of this Ordinance, may be seized and taken to the most

accessible police station, and the officer in charge of the said station may take possession of the same, and if necessary, retain the same for the purpose of producing them before the court.

Provided always that the said cattle and vehicles shall not be seized and taken to the police station if in charge of a person having a well known domicile.

27.—If such cattle, vehicles, or other aforesaid, do not belong to the person contravening as aforesaid, they shall, pending the disposal of the complaint, be restored to the owner thereof on an application by him to that effect to the magistrate, with or without security, for their reproduction in the discretion of the magistrate, and if they belong wholly or partially to the person contravening, they may be restored to him on satisfactory security being found for their reproduction or payment of the value thereof, which value shall be fixed by the magistrate in the bail bond taken by him.

28.—If the charge made against the offender be dismissed, the said cattle, vehicles, or other aforesaid, shall be restored to him, and the expense of keeping and maintaining the cattle seized as aforesaid, shall be paid to the officer in charge of the same, out of the colonial treasury, upon a duly taxed bill, provided that no more than one shilling a day per head of cattle shall be allowed to such officer for all care and expense in connection therewith.

29.—If the person so arrested be convicted, and a fine imposed, the judge or magistrate before whom the case was tried, may, in default of payment of the fine, order the said cattle or other aforesaid, if they belong wholly or in part to the offender, to be sold, and the proceeds of the sale, or so much thereof as shall represent the proportionate share of the offender therein to be applied in payment or part payment of the said fine and costs. Such sale shall be made by an usher of the Court before whom the case was tried.

30.—Wood seized as aforesaid shall be forfeited to the Crown, if the accused be convicted, or returned to the owner if he be not the delinquent.

31.—In any case in which an arrest or seizure shall be made on account of an alleged contravention of any provision of this Ordinance, and in which the judge or magistrate before whom the case is brought, shall order the release of the person arrested, or shall direct that the article seized be restored to the claimant thereof, the said judge or magistrate, if he shall be of opinion that there was probable cause of arrest or seizure, shall certify the same on the record of the case at the time of giving judgment.

Such certificate shall effectually bar any right of action or prosecution which the party arrested or claiming the article seized, or any other person having an interest in such arrest

or seizure might otherwise have had against any person on account of such arrest or seizure.

32.—The guardian of woods and forests, any forest ranger, or any inspector, officer or constable of police, or any clerk or officer of the Surveyor-General's Department, may enter and cross any land for the purpose of visiting or inspecting any Crown land or any reserves.

Provided that no one shall enter or cross any private yard, camp, garden, or enclosed place, without a warrant under the hand of the magistrate of the district in which such yard, camp, garden, or other aforesaid is situate.

33.—It shall be lawful for the owner or occupier of any reserves, forest or plantation of trees belonging to a private individual or for any person authorized by him, or for any forest ranger, officer or constable of police in the case of any reserves, or of any Crown land, to seize or destroy any animal, except beasts of burden, deer or game found feeding on the leaves of any tree, in any such reserves, Crown lands, forests or plantation of trees.

All animals seized or destroyed under this Article shall *ipso facto* be forfeited to the Crown.

34.—Any person who shall, by violence, intimidation, menace or otherwise, obstruct or hinder, or who shall assault any person acting under the authority of this Ordinance and for the execution of the provisions thereof, shall be liable to a fine not exceeding fifty pounds sterling, or to imprisonment not exceeding six months, without prejudice to the right of the Ministére Public to prosecute any such offender under any other law of the Colony.

CHAPTER V.

Legal Procedure.

35.—Offences against the provisions of this Ordinance shall be prosecuted before the district magistrate of the district where the offence is alleged to have been committed, when the aggregate amount of the penalties sought to be recovered does not exceed fifty pounds sterling.

36.—Offences against the provisions of this Ordinance, within the jurisdiction of district magistrates, may be prosecuted in the case of Crown land or reserves by the Surveyor-General, the guardian of woods and forests, any forest ranger, or any inspector or officer or constable of police, and in the case of forests or plantations of trees belonging to private persons, by the owner or occupier of the land, or their representatives upon which the offence is alleged to have been committed.

37.—No conviction pronounced by a district magistrate under the provisions of this Ordinance, may be appealed against or removed by certiorari, or in any other way shal-

lenged or disturbed, unless the person convicted be sentenced to a fine of ten pounds or upwards, or to imprisonment.

38.—Nothing herein contained shall affect the right of the Procureur-General to stop any prosecution instituted by any person authorized to prosecute as aforesaid, and if he deem proper, to file a fresh information, and to begin new proceedings before the competent Court.

39.—When the aggregate amount of the penalties incurred in respect of any offence against the provisions of this Ordinance, shall exceed fifty pounds, the Ministeré Public may exhibit an information against the defendant (a copy of which shall be served on him at least fourteen days before the day of trial) and may sue for and recover the same before a Judge of the Supreme Court, without a jury; reserving always to the Procureur-General the power to lay such aggregate penalties at a sum not exceeding fifty pounds, and to cause the prosecution to be conducted before the competent District Court.

40. No information made under the provisions of this Ordinance, and no proceedings following thereon, shall be invalidated or quashed for want of form; but any defect or irregularity in any such information or other proceeding, may be amended at any stage of the case by the judge or magistrate so as to ensure a fair trial on the merits of the case.

Provided that the judge or magistrate shall, if the nature of the amendment require it, adjourn the trial of any case.

41.—In any prosecution under this Ordinance, the information on oath of any forest ranger or of any police officer or constable, or of any clerk or officer of the Surveyor-General's Department, shall be deemed to be *primâ facie* evidence of the guilt of the person charged therein.

42.—All fines and forfeitures recovered under this Ordinance shall accrue to the colonial treasury; but one-third of such fines or forfeitures shall be paid into the Forest Rangers' Fund, and any portion thereof may, in case of special meritorious conduct, be awarded to any forest ranger, or officer or constable of police by His Excellency the Governor.

CHAPTER VI.

Repeal of Laws.

43.—The following Laws are hereby repealed:—

1*st.*—The Ordinance of 17th June 1769 (Code Delaleu, No. 179).

2*nd.*—The Economical Regulations of 15th November 1769 (Code Delaleu, No. 183).

3*rd.*—Ordinance No. 192 (Code Delaleu).

4*th.* Article 2nd of Ordinance No. 193 (Code Delaleu).

5*th.* The Arrêté of the 5th May 1807 (Code Decaen, No. 144).

6*th*.—Ordinance No. 30 of 1854.
7*th*.—Ordinance No. 21 of 1856.
8*th*.—The Proclamation of the 11th May 1865.
9*th*.—Ordinance No. 9 of 1872.
10*th*.—Ordinance No. 12 of 1872.
11*th*.—All parts of Colonial Laws, Arrêtés, Proclamations, Notices, or Ordinances which may be contrary to, or inconsistent with, the provisions of this Ordinance.

PASSED in Council, at Port Louis, Island of Mauritius, this twenty-third day of March one thousand eight hundred and seventy-five.

J. KYSHE,
Acting Secretary to the Council of Government.

Published by Order of His Excellency the Governor.

EDWARD NEWTON,
Colonial Secretary.

Plantations at Kuch Behar.

WHILST staying at Kuch Behar lately, I examined some interesting plantations which have been made there within the last few years. Those of teak are the most extensive, though by no means the most successful. The seed was sown in 1874-75 in nurseries, and the seedlings planted out at distances of five and six feet, but the ground selected being but slightly elevated above the paddy fields, their roots get water-logged in the rains, and consequently most of them are stunted and of little promise. Judicious draining, however, might improve matters.

The teak planted by the side of a road leading to the bazaar, and on a slight eminence in the former plantation, show a better growth. The best sapling there is fairly straight and cylindrical, and measured 2 feet 9 inches in girth and 50 feet in height.

The sissu was sown in a nursery in 1872-73, and some of the seedlings planted out at distances of 16 feet on land lower than that of the teak plantation, and liable to be slightly flooded in the rains. The girth of an average tree is 2 feet 3 inches and the largest girth 3 feet 2 inches and the height of the plantation about 50 feet.

The trees are somewhat crooked, and branch out before developing their trunks, but their condition would doubtless have been improved by closer planting.

In another plantation the sissu seedlings were planted out, in the same year, at distances of 27 feet, on higher land which is never flooded. Here the largest tree measures 3 feet 10 inches in girth, and the total height of the plantation is the same as

before, but the trees have shoot trunks, and are very much branched.

The khair (*Acacia catechu*) plantation consists of saplings, from seed sown in 1873 and 1874, planted out at distances of 5½ feet. They are fairly straight, but many have been blown out of the perpendicular. The average girth is 1 foot 6 inches, the largest measured being 2 feet 1 inch, and the height is the same as that of the sissu. The site chosen is on land similar to that of the second sissu plantation.

The general aspect of the khair and sissu trees is healthy and vigorous.

I heard a local objection raised to khair plantations that the trees never attain large dimensions, but I have seen khair trees in the Eastern Duars fully 6 feet in girth, and of considerable length of trunk.

Small khair trees are also very useful for house posts for native *huts and shops,* and for which *purpose* sissu would not be available on account of its high value and larger dimensions. It is, therefore, certainly worth while to plant out khair, which is an indigenous species in Kuch Behar.

There is also a small sâl plantation, which was made in 1874-75, by planting out at distances of 7 feet seedlings about 18 inches in length, which had been brought from a sâl forest in the Western Duars, at a considerable distance from Kuch Behar. The saplings have an average girth of 1 foot 3 inches, that of the largest being 1 foot 6 inches. The tallest trees are in the centre, and are about 30 feet in height, the inferior height of the outer trees of the plantation being quite perceptible, and plainly showing that sâl prefers a dense growth.

This plantation has been very successful, there being scarcely a vacancy, and the saplings are full of vigour.

It would be of great interest to foresters if certain trees of the sâl, sissu, and khair plantations were marked, and their dimensions measured and recorded annually with a view of assisting to determine the rate of growth of these species.

A few jarúl trees (*Largerstræmia Reginæ*) were also planted out *in 1873-74, but have made little progress although they* apappear to be healthy, the girth of the largest being 2 feet 4 inches and its height 16 feet. But it has more the pearance of a shrub than of a tree, its trunk being only 6 feet long before branching out freely.

Greater moisture is required for this species, which delights in marshy ground, and flourishes along water-courses which overflow their banks in the rains, and in the damp forests of Darrang in Assam the tree attains large dimensions.

The soil in the plantations consists of a sandy loam, and is normally covered with thatching grass, except in the lower sissu plantation, where the soil is darker colored and swampy, and kutchu plants abound.

The Government of the Kuch Behar State is taking advantage of existing patches of khair forest in the low-land near some of the water-courses to plant out khair and sissu, and to sow seed of their species in furrows ploughed up at intervals of a few feet.

Over 1,500 sâl seedlings were also brought from the Western Duars in 1879-80, and planted out near the station, but this method is expensive. There are three small blocks of sâl forest in the State, and it is to be hoped that they will be looked after, and the area increased by plantations of sâl and other trees, as the scarcity of timber is already severely felt, and teak is imported at a cost of Rs. 3-12 per cubic foot for local works. Sissu from the Western Duars is now in the Artizans' School, where all kinds of carpenters' and wheelwrights' work are undertaken.

The scheme for those plantations, made during the Maharajah's minority, doubtless originated from the proximity of large areas of Government and private forests in the neighbouring districts of Jalpaiguri and Goalpara, comparison with which attracted the attention of Government to the unwooded state of Kuch Behar; but the people of other plains districts in Bengal, who are almost entirely restricted to the use of bamboo for their house posts, must suffer great inconvenience from the necessity of replacing them every two or three years. This must be particularly troublesome to shop-keepers and merchants, as the bamboo posts of their buildings allow the white ants to have access to their stores and to the roofs of their houses.

It is also a question for the agriculturalist whether the use of cowdung as fuel can go on indefinitely without impoverishing the soil, and whether Government should not endeavour to establish fuel reserves for the people.

But little is being done to utilize or reserve such waste lands as still exist for plantation, and it may be thought that the permament settlement bars the way to such improvements. Government, however, still retains the right to acquire forest land in the interests of the country, and proprietors might probably be induced to part with areas which may be of little use for cultivation, provided they were adequately compensated.

The large private forests of the Goalpara district, comprising an area of nearly 500 square miles, principally of sâl forests, and admirably situated with respect to land and water carriage, have supplied hundreds of thousands of house posts and small timber for Lower Bengal, since British rule was established, and the zemindars of that district have lately been further enriched by the acquisition of large tracts of sâl forest in the Garo Hills where, ten years ago, when the Garos were independent, neither they nor their agents dare

scarcely show their faces. Hardly a tree over three feet in girth can now be found in these forests, and it is likely enough that, as the proprietors find their forest revenue dwindle away, they will give up the forests to the wasteful system of cultivation called jhooming, which prevails in these parts, and which, if persisted in, will end in eradicating the sâl.

In this manner the private forests in the neighbouring districts of Rangpur and Maimensingh have almost disappeared, though they still contain a few patches of sâl forest worth protecting, and of being increasing in area by planting after the model set by the Kuch Behar State.

I do not wish to over-estimate the work done there, and the area of the plantations referred to are at present only trifling; but the project of improving and extending by plantation the tracts of khair and sâl forest still left in the State is very commendable, and might be followed with advantage in other plains districts of Bengal.

When we consider that the forests in France occupy more than a sixth part of her area, and are preserved both in her plains and hill tracts, we can only wonder at the apathy which would allow forests to disappear from the plains of India, or make no effort to restore those which formerly existed.

Forests fairly stocked with saplings, although destitute of mature timber, are of the same character as plantations, which could only be made artificially after a very great expenditure.

Private owners, as a rule, will do very little to preserve their forests, and nothing to improve them, and the present Government Forests of Assam and Bengal will probably only be found capable of supplying the demand for large timber suitable for various trades and public works. It is, therefore, worthy of consideration, whether in order to ensure a supply of building material and fuel for the millions in Bengal, a far-seeing Government might not now, at a comparatively small cost, acquire possession of the private forests which are still left, and endeavour to improve them and to create reserves by plantation in districts where they have ceased to exist.

W. R. F.

Trees as a protection from hot or violent winds.

In the correspondence column of the *Indian Tea Gazette* of the 4th April 1881, two letters, hereunto appended, have appeared, which discuss the practical benefit derived from trees or shrubs as affording protection to a tea garden against hot winds.

As all the services which trees are capable of rendering to the community form a subject of study for forest officers, and the power of resistance to the wind possessed by belts of

trees is an important consideration in arranging the order of felling (*assiette des coupes*), I hope that the following remarks may prove interesting to the readers of the *Indian Forester*, and, if at the same time they are of any service to the correspondents of the *Indian Tea Gazette*, whose letters have called them forth, my object in writing them will be fully attained.

The effect of forests in tampering and checking the force of the wind is frequently alluded to by writers on forest economy; and if I quote a few of the passages which I have met with, it is because I think that will be the most conclusive manner of testifying to this important *rôle* of protection which trees and forests perform for the benefit of neighbouring cultivation.

The Americans, who have often been reproached with the wanton destruction of their forests, are now endeavouring to re-establish them. A notice on the subject, by Mr. G. P. Marsh, which occurs in the *Revue des Eaux et Forêts* for October 1880, under the title, "*Le reboisement aux Etats-Unis*, begins by pointing out the value of trees to the settler on the prairie as a protection against the wind. The passage, translated from the French, is as follows:—

"None can better appreciate the benefits conferred by forests than the settler on the prairie, whose dwelling is ever exposed, as a ship on the ocean, to the fury of the violent and changeful winds which sweep across the bare and level plains where no obstacle checks their impetuous career.

"Seated by the hearth in the depth of winter when his dwelling, buried in snow, looks like a mole-hill in the midst of a vast expanse of moorland, he regrets that, when some 20 or 30 years ago he was selecting a site for his dwelling, he did not plant out with trees a few patches of hundreds of acres of which his holding consists. Had he done so, his house would now be snug and quiet, with a fine clump of trees to shelter it from the north-west wind. His garden would not be dried up by the first dry wind of summer; and he would not see his fruit blown off and destroyed by the wind.

* * * * * *

"There are very few among the pioneers of the far West who have had this forethought; but the wisdom of those few is now so manifest, that from one end of the prairie to the other it is felt that the planting of trees is an object of public importance."

As shewing the advantages expected from this planting of trees, the last paragraph of the extract from *The Scientific American*, entitled: "Preservation of Forests," which appeared in the *Indian Forester* for July 1879, may be quoted:—"Any State where these precautions" (planting groves of trees, quickset hedges, trees on road sides, &c.) "should be generally adopted, would soon be so unmistakeably distinguished by

the unfailing humidity and freshness of its fields and the abundance of its crops that the sheer necessity of competition would induce backward neighbours to try the same experiment, and before long the maxim would not only be generally recognized, but generally acted upon, that husbandry and tree culture are inseparable."

This certainly points to practical benefit to be derived by agriculture or other cultivation from the planting of trees in their vicinity; and this, too, without its being necessary to establish extensive forests, or even to distribute the trees with the special object of forming a protective belt.

Forests, too, are effectual in tempering the winds, rendering the climate of the place more equable.—(*Baudrillart, Dictionnaire Forestier.*)

A writer in the "*Indépendance Belge*" of 18th June 1865 thus describes the effect of forest trees:—

"1*st*.—They prevent the sun's rays from reaching the ground and heating it.

"2*nd*.—By the expanse of branches and leaves they multiply the cooling surfaces affected by nocturnal radiation.

"3*rd*.—The upper layers of the air, cooled in the tree tops of the forest, sink, by their increased density, towards the earth, and thus is kept up a degree of cold considerable in its intensity, and thereby a well maintained moisture.

"From what has just been stated it may be clearly deduced by scientific reasoning that forests lower the temperature of their locality and render the climate at once cooler and moister."

I believe that these views are rather one-sided, and that the fact really is that, as forests absorb or part with heat very slowly, and as the air inside the forests is not renewed so freely as it is in the open, forests have an equalizing and regulating effect on the heat of the local climate, and tend to absorb the heat of hot winds and to give back this heat as the weather becomes colder.

In the "Transactions of the Academy of Science of France" (*Comptes Rendues*) Vol. LX., sitting of the 10th April 1865, a memorandum may be found which establishes the opinion that forests afford shelter from the wind to cultivation in their neighbourhood; and it is pointed out that this action is more effectual the higher the trees.

It has been noticed in many countries that extensive denudation has caused hot winds in summer and hail-storms in winter. Thus the occurrence of hail-storms has been remarked in the vineyards of many parts of France to have been caused by the destruction of a screen of forest vegetation which previously warded off the winds and their attendant storms.

A well-known instance of the protection afforded by plantations of trees is the great work of fixing the rolling sand

hills in the Departments of the *Gironde* and *Landes*, which was first effected by Bremontier, and is still being carried on. In this case not only had the wind to be combated, but the substance of a moving range of sand-hills to be consolidated, so that the wind should not be able to roll it, piecemeal, inland.

The authority of M. Lorentz and Parade (*Culture des bois*) will, I feel sure, be admitted on this subject to be the best that can be adduced. Speaking of the climate of plains, (p. 21, 5th edition) we are told that "the absence of forests or other plantations makes itself felt (just as the total absence of large surfaces of water) by an increased heat and drought in summer, and in winter adds to the intensity of the cold."

As regards the effect of a *belt of trees* in protecting the ground behind it from the wind, the third chapter of the work just quoted, treating of the laying out of compartments of forest for felling, contains much that is instructive. The following passage (pp. 205, 206) is particularly applicable:—"It is an addition to the advantages of the rule we have just been discussing to leave standing on the west and south margins of the forest, when the fellings reach those parts, a belt of trees forming deep forest of a width more or less considerable (100 to 50 feet) according as the place is exposed or sheltered, as the trees are deep-rooted or the reverse, &c. It is well known that near the margins of a wood the trees are generally more branchy and stunted, and more firmly rooted than in the interior, and that having grown up under the constant action of the wind they naturally withstand its violence better."

Monsieur Bagneris, in his *Manuel de Sylviculture*, concludes his remarks on the admitted climatic effect of forests in these words:—"Lastly, the forests break the force of the winds and check their violence." Again (p. 218) on the subject of laying out compartments for felling: "When the side directly exposed to the wind is reached, it is always necessary to maintain intact on that side a zone to be kept up as deep forest and worked by selection fellings. The width to be given to this belt must vary according to the resistance it has to offer; but, to be effectual, it is seldom that it can be made less than a hundred yards wide."

On exposed ridges or plateaux, as well as in narrow valleys swept by the wind, it is often necessary to increase the width.

In the "*Indépendance Belge*" of the 20th June 1865 the use of forests as screens to protect cultivation from the wind is discussed. Their influence—and Arago is cited in support of this view)—is one of equalization; and the writer proceeds to say: "It is for man, and particularly for the agriculturist, to know how to constitute such screens as will be free from any drawbacks that might be presented by dense forests of

vast extent. Now for this purpose extensive forests are not needed; screens of trees, quick-set hedges, plantations round the homestead and along the roads will afford ample shelter, without occasioning, as forests might, late spring frosts and thereby often endangering the crops."

The circumstances of different localities must necessarily vary so greatly that no rule can be laid down as to the width of the belt of trees; but as regards shrubs and quick-set hedges affording ample shelter, that, I think, depends on the intensity of the danger to be counteracted and the extent of ground to be protected. The resistance of the belt of trees will be in proportion to its density and the firmness with which the trees in it are rooted; the extent of ground it will protect will be greater or less as the trees forming it are tall or short.

I believe that the distance behind the belt to which the shelter extends is about twenty times the height of the screen. No doubt there is some mathematical formula, whereby, with certain data, it might be computed; but the surest and simplest plan will be to rely on actual observation in each case. One may expect that a low wind sweeping over a level plain, and a wind coming in a slanting direction, as from the side of a mountain, would not be counteracted to the same extent by a belt of trees of a given height,—so that I should expect to find the extent of ground sheltered to depend very much on the angle of incidence of the wind.

As to the best kinds of trees to be planted, in the absence of existing timber, they must above all be suitable to the soil and climate—of hardy growth, capable of growing up in the exposed situation where they are to be placed. Such as are gregarious and will form a dense thicket are to be preferred, and valuable kinds, if suitable in other respects, should be used in preference to those which are useless as timber. If the winds to be counteracted are constant, evergreen trees, which keep their foliage throughout the year, are to be preferred to deciduous kinds. According as the winds are hot or cold the kinds *should be chosen* which are best suited in this respect; thus, in Europe, the scotch fir (*Pinus sylvestris*, Linn.) is found to resist cold better than the maritime pine (*Pinus maritima*, Linn.), which, in the winter of 1879, succumbed to the cold extensively in the north and centre of France.

Sissu (*Dalbergia Sissoo*, Roxb.), which is recommended by both "E." and "Aliste" for very good reasons as suitable for planting in amongst the tea bushes, would be very useful also for the belt of jungle as it is gregarious and hardy, growing in the stoniest soil of river beds exposed to the winds which sweep down the valleys. It is also a quick grower, and the wood is valuable for cart wheels, furniture, gun carri-

ages, &c.; but it does not, as a rule, form compact or dense forest. It would be useful on the outside of the belt by its hardy temperament and firm root hold.

Bamboos have the advantage of growing to their full height very quickly, and when propagated by off-sets they form good-sized clumps in three or four years. "Aliste" remarks that the bamboos in his part of the county are all flowering, and asks if there is no remedy to prevent their dying after running to seed. I believe there is not. I was informed a few years ago that the bamboos in a part of Orissa had all died in this way. In Drury's "Useful Plants," 2nd edition, p. 64, we find that "at the age of 15 years the bamboo is said to bear fruit—a whitish seed-like rice, and then to die." I have noticed that the forest bamboo of the Terai, *(Dendrocalamus Hamiltonii)* is flowering pretty generally this year; but the phenomenon does not universally affect all the bamboos. I have also noticed clumps of this bamboo in a languishing condition which had lately flowered.

The bamboo is very useful to tea planters, and is frequently planted on estates in the Darjeeling Terai. It is also very firmly rooted, and the clumps have a good broad base. This is important at least for the outside of the belt as they may be used in places of deep-rooted trees should the soil not be deep enough for their growth. But whatever tree or shrub is used on the outside, all the low branches must be kept. Stunted trees, with branches feathering down to the ground, will be most useful. At page 68 of the INDIAN FORESTER for July 1880 this sentence occurs :—

"In exposed situations both the pruning and thinning of trees should be much lighter round those margins of plantations which face the prevailing high winds of the district. By too close packing it often happens that only the face of the very outermost trees are dotted with foliage, so that any injury to one of these admits the destructive winds. This may be guarded against by a judicious early thinning of such margins, so as to secure a belt of low-branched trees—(A. J. Burrows, in *The Garden*)."

The India-rubber (*Ficus elastica*, Roxb.) would be a good evergreen tree for the outside edge where permanent foliage is desired. It will grow in most soils provided they are well drained and permeable; and it also requires plenty of sun light. Its roots take firm hold of the soil. *Cedrela Toona* might also be grown as suggested. It is a shade-loving tree, and its being planted amongst other kinds would draw it up with a fine clean stem, so that the trees would be likely to give good timber. The toon is capable of attaining a height of seventy feet or thereabouts, but requires a moist, rich, soil and a sheltered situation, otherwise its growth is stunted. The young plants are apt to be broken by deer browsing on the

leaves. The new shoots also suffer from the attacks of a grub which eats into the pith.

If the soil is suitable it would be worth while to grow toon, as the timber is greatly esteemed for tea boxes and furniture.

As regards the raising of sissu in a nursery as recommended by "E," I think under the circumstances it would be a waste of time. Sown broadcast, sissu germinates very readily, and the seedlings grow far more rapidly than the plants raised in the nursery and then transplanted. It would be better to sow broadcast over the whole of the proposed belt and to thin out any plants required for planting in the tea replacing them by toon, &c. Sissu seed is very plentifully produced, and is easy of collection as the pods are indehiscent, and there is no danger in leaving it to get fully ripe upon the trees.

Toon seed, however, should be collected as soon as the fruit begins to ripen, for if the capsules are left to open, all the seed, which is very light, will be lost. Toon may with advantage be raised in a nursery, as it requires particular care to screen the seed beds from the sun and to protect the young seedlings for the first few weeks. To effect this, a rough roof of elephant grass or loosely-woven mats, through which the sunshine can filter as through a cullender, should be erected over the seed beds. The seed should only be lightly sprinkled over with earth. The best time for sowing is early in the rains, as soon after the seed has been collected as the ground gets damp and warm.

The germination of the seed of *Ficus elastica* is rather difficult. It requires a well-drained soil, yet a warm moist atmosphere like that of a greenhouse; the seed should be fresh gathered; the beds should be heaped up in little mounds and the seed sprinkled *on the sides of the mounds*. Pounded brick and charcoal have been tried as soils for the seed-beds. I would recommend a compost more apt to retain moisture, a mixture of pounded brick, charcoal, decayed leaf-mould and moss gathered from the branches of trees; and that the mounds be made with this.

Water should be given often enough to keep the seed-beds moist, but they should not be deluged with water, nor should very cold water be given but having the same temperature as the soil.

The *Ficus elastica* grows readily from cuttings, if struck in soil that has been well hoed up, and the cuttings are put in during rainy weather when the soil is warm, say July or August, in a sunny place.

Wherever possible it would of course be preferable to utilize existing trees; for, however quick-growing the kinds planted may be, it will take a long time for them to attain their full height, or, in other words, their maximum protective effect. But it seems that the garden "F." alludes to is situated on an

open space *as yet* too slightly wooded. To judge, however, by the opinion of a correspondent of the *Indian Tea Gazette* who writes from the Nilgiris, planters do not always select the site of their plantations with a careful regard to the local conditions affecting climate. He says: "I am inclined to the idea that a want of special knowledge has contributed greatly to the non-success of tea growing here. In many instances very exposed windy situations have been chosen instead of the low-lying humid valleys; and sometimes, I think, fixing the site of a bungalow on a nice spot, and having the tea cultivation close by, has had something to do with it." It is interesting to see that tea planters who occupy a most important area in many districts and have a great landed interest in the country, take interest in forests for the sake of the protection they afford, as well as for the produce they may yield.

F. B. MANSON.

THE PRACTICAL BENEFIT OF TREES OR SHRUBS AS A MEANS OF STOPPING THE FORCE AND EFFECTS OF THE WIND.

SIR,—"F." your "special correspondent" for Dehra Doon, wants to know "the practical benefit, if any, of trees or shrubs as a means of stopping the force and effects of the wind?"

I gather from "F.'s" letter that the garden he knows of is visited by hot winds; they cannot, however, have a very long and lasting effect, otherwise the very creditable yield of "426 lbs. of tea per acre over an area of 712 acres" could not surely be obtained. All the same, the winds must be very bad for tea, no matter how slight; and I for one can, I think, understand "F.'s" apparent anxiety to overcome the evil caused by them. There is no doubt that trees do, to a certain extent, break the force and effect of wind, and as the garden "F." alludes to is "on an open space as yet too slightly wooded," it would certainly do no harm to plant more trees all over it. I would recommend his laying down nurseries of sissu, (the seed must be easily procurable in the Doon), and removing the seedlings when they have well grown, and are three to four feet high. I would plant them all over the garden—in the tea, and by the roads; any ground in, or near the garden not fit for tea might I think, advantageously be turned into a clump of sissu trees. I suggest the sissu, as I know tea grows well under its shade, as it is not a surface feeder, and consequently strikes its roots well down, and not into the tea bush.

If I had ever so little hot wind to contend against, I would be very careful to leave the outside of my bushes well covered, so that my *bushes themselves might offer resistance to such wind*, and I would be very careful how I thinned out. I would cultivate my garden highly, so that my *bushes would be able to stand a little hot wind*. I would see that the bushes are in a good healthy state, and not being over-pruned or over-plucked; but I believe the best advice I can give "F." is to do pretty much the same as is done where they get 426lbs. of tea per acre over an area of 712 acres," which is certainly *not bad* for a "non-regulation tea district."

"E."

PLAN FOR PROTECTING A PLANTATION FROM THE HOT WINDS.

SIR,—I have just been reading the very interesting letter of your Special in these parts; and I cannot help but take up my pen and follow his example, as far as my poor abilities will allow. Tea in all its branches is an inexhaustible subject to write about, and here in the Doon, I may say, the Tea Industry has scarcely passed its infancy, consequently any amount of information is needed on various points relating to its cultivation and manufacture, about which opinions are so very diversified

at present. I am glad to see one like "F." boldly take up his quill and freely ask for information; at the same time willingly contributing his quota of knowledge for the benefit of his brother planters. If only others could be persuaded to follow his example, in, even, so little as to scribble a few lines, and give their opinions occasionally, I am sure a large amount of useful and profitable information would be published, which would benefit everybody.

"F." writes to ask if any plan can be devised for protecting a plantation that suffers from the hot winds. His idea of planting belts of trees, and thick rose-hedges would, in my belief, be not found to answer practically, though in theory it seems good. Not only would it be a very expensive and troublesome operation planting out and tending this belt of trees, but in the end it would not protect the whole of his garden, but simply have effect on those bushes immediately alongside. No belt of trees, unless dense, and all but impenetrable, and from 50 to 100 yards wide, could effectually break the force of the hot winds we have sometimes in April and May. I believe there is no complete remedy for a garden so exposed, so we must look for a partial mitigation of the evil only. It is not only the scorching dry winds, but also the burning vertical rays of the sun, that shrivel up and kill the bush. This last evil can easily be overcome by planting suitable trees in among the tea. It costs comparatively little, and the trees can easily be manured, pruned, hoed, etc., at the same time as the surrounding tea. The tree, *facils princeps*, for a tea plantation, is the sissum or sissa *(Dalbergia sissoo)*, for the following reasons: it is a fast grower; has deep roots, not surface feeders; it is covered with foliage during the hottest time of the year, giving a light equable shade, and its sheds all its leaves and seed-pods during the cold weather, when shade is not wanted, the leaves, etc., forming valuable leaf mould; added to this, it is a handsome tree. Next to the sissum, one might plant the toon *(Cedrela Toona)*, which is also a good tree, but not so good as the former. Both are valuable as timber. Besides these two, I would not plant any other kind of tree in among the tea; all others seem to have some injurious effect. But above all never have a mulberry even close to tea; its roots spread out and are almost entirely surface feeders, and the droppings of leaves and berries have a sort of blighting effect on anything growing underneath. There are a number of other trees that do undoubted harm to the tea bush, but they are too many to enumerate here, and I believe are fairly well known to those interested in the matter.

While on the subject of trees, I may, *en passant*, mention an unusual phenomenon up here, that is the seeding of all the bamboos, which add so much to the beauty and appearance of our charming little station. I believe it is a well-authenticated fact that the bamboo dies immediately after running to seed. Is there no remedy for this? Would not cutting them down to the roots, while they are still in flower, tend to save them? I dare say some one of your numerous readers down in Bengal could enlighten us all on the point. It would be such a pity to lose all the beautiful feathery clumps we have alongside our roadways here, from sheer ignorance about their life and growth.

ALISTR.

Dehra Doon, 29th March 1881.

—(*Indian Tea Gazette*)

Effects of Forest Denudation on the Deccan side of the Western Ghats.

The chain of mountains, known as the Sahyadri Ghats, which lie between the Konkan and the Mawal country of the Deccan (both southern and northern), is very interesting and instructive to foresters, as it abounds in valuable trees and new and rare plants. There is a strange contrast in the character of the vegetation, which is found on the two opposite slopes, the eastern or Deccan side of the Ghats, having its crest covered with moist forest, while the western slopes facing the Konkan are occupied with dry deciduous vegetation. The temperature as well and the habits of the people widely differ, though the configuration of the country, both in the Konkan and the Deccan, is somewhat alike.

The several rivers, such as the Krishna, Godavari and Bheema (the great drainers of the Deccan), with their tributaries too well known and too numerous to be mentioned here, have their head waters on the crest of the Ghats, and run in an easterly or south-easterly direction through the fertile plains and rich valleys, bounded by the spurs of Sahyadri, which stretch eastward and separate the river valleys. These cross ranges of hills give rise to, and feed numerous streams and perennial springs, which ultimately throw themselves into the aforesaid rivers.

The Western Ghats and their off-shoots were all at one time covered with splendid vegetation; but having been invaded by a rude cultivation, which existed until a very recent date, they have been deprived of their natural covering in a more or less degree.

This attack on the tree growth was, perhaps, arranged by the rural tribes with the innocent desire of securing a bare subsistence, and not to defeat the efforts of nature in producing trees and shrubs for the comfort of man and to serve his purposes.

It is not that the cultivation of the hill land extended along with the increase of population; but it is probably due to the inveterate habits of the people, who preferred to get a small produce off an extended area of cultivation, than by a system of farming, manuring, and rotation of crops to make a small, but compact, area yield the same, or a larger return with less expense.

The natural consequence of all this is, that the outturn of an acre of cultivated land is now far less in quantity and quality than what it used to be some time ago. But that is partly attributed to the soil not being allowed sufficient rest in order to regain what it has lost in the shape of fertilizing ingredients, and partly to the loss of natural manure, con-

sequent on the destruction of all the vegetation on the hill slopes, the artificial manure being utilized for other than legitimate purposes.

Besides, with the disappearance of the forests, the rainfall has become uncertain, though the quantity falling every year does not seem to have diminished. That the absence of trees promotes aridity in the soil is now perfectly deducible from the scientific researches and observations which have been made both in Europe and in India, and this absence renders the soil quite incapable of absorbing the surplus rain water, of letting it out in the form of springs and flowing perennial streams, and of retaining moisture within itself so as to produce subsoil irrigation. It would not, therefore, seem unlikely, even to the casual observer, that each of the above and other causes has more or less, under different combinations of circumstances, contributed to diminish the productive power of the cultivated lands, both in the neighbourhood and at a distance from the place of forest denudation.

Even the old inhabitants of the Deccan districts, though they feel no interest in ascertaining the causes of such phenomena, have begun to see that several springs have disappeared, the climate has become greatly drier, the seasons more uncertain, and the land less fertile.

Simultaneously with the change in the climate and with forest denudation, a change in the production of crops followed inevitably, and wherever the soil becomes unfit to produce wet crops, the cultivation of dry crops is being substituted, but it is feared with no great benefit to the cultivators. Dry crops usually thrive well in localities where the average rainfall is less than 30 inches, and where the ground is beyond the influence of the south-west monsoon; but here the dry crops seem to have migrated far to the west and in a moist climate near about the Ghats, where, as has already been said, the rainfall is not diminished, and is more than 75 inches, and though its fall has become uncertain, or rather unseasonable, it often rains continuously and copiously so as to injure both dry and wet crops, the former owing to excess moisture produced by continued and heavy fall of the south-western rains, and the latter for want of it, when the rains withhold at times, when it is required, owing, as previously remarked, to the rainfall having become uncertain.

Thus, with the extension of cultivation at the sacrifice of forest property, and with the change in the growing crops, the condition of the ryot does not seem to have in any way improved; on the contrary he is sinking into difficulties, which are likely to increase, as time rolls on, through his ignorance and consequent disregard of the laws of nature. He is not only obliged to remain half-starved for a considerable period of the year, subsisting only on the produce of the jungles,

which too he is refused by what seems to him the avenging hand of nature, and even then he is hardly able to pay assessment due on the large area of land unnecessarily brought under cultivation, nor is he able to provide himself, or his family, with the other necessaries of life. Such a state of things is no doubt pitiable, and instances thereof will be found in almost all the villages in the Deccan.

In the majority of cases, the ryot is compelled to sell other things than the produce of his fields, which accidentally happen to be in his possession, such as cattle, fruit trees, like *Fanas* and *Amba*, to satisfy the demands of the treasury, or those of the sowkar (money-lender).

Now the question naturally arises, whether the land revenue will in any way continue to be augmented as has hitherto been the case, though that increase was due more to the extension of cultivation of the hill lands than any thing else, and punctually realized without any trouble despite the wretched condition to which the ryot is reduced? And whether the assessment fixed by the Survey Department on the different descriptions of cultivated lands is in any way heavy? But such, it is believed, would not be the case. On the contrary, it seems very probable that the income derived from the land revenue will eventually suffer to a great extent, and it would be difficult, if not impossible, to realize the whole amount of assessment, as is now evident from the large area of land which is being annually thrown up by the ryots under a pretext of heavy assessment—the real cause, however, of such proceeding being the incapacity of the land to remunerate the cultivators owing to constant cropping.

The condition of the ryot residing in the Eastern part seems somewhat better than that of his brother in the West, owing to the adoption of rather an improved mode of cultivation, which he is forced to resort to, as nothing is left for him to depend upon in the shape of forest produce like his neighbour in the West, and he is gradually compelled to resign indolent habits to earn his bread. But still his condition does not seem to be very enviable; because it is to be borne in mind that the fertility of the land in the broad and rich valleys in the East depends mainly on the great rivers, which take their rise in the Western Ghats, and on the artificial manuring with animal refuse which is now otherwise utilized.

Apart from the climatic effects produced by the growth of trees on the country generally, their preservation is important on other grounds. Much wood is every day used by the ryots, and it is as essential to the general well-being of the people as food and water. The demand for wood is great, and will be greater still, owing to the railway line running through the greater portion of the Deccan.

Thus, when it was found that public interests were at stake, the Forest Conservancy in the Deccan and in other parts of the presidency could not be neglected any longer, the Inspector-General was invited in 1870 to visit the remnant, of the forests of Bombay for the purpose of devising measures for their future management. No practical effect, however, was given to his excellent suggestions until Sir Richard Temple, the staunch friend of Forest Conservancy in India, became Governor of Bombay.

During the time Sir R. Temple was at the head of the Bombay Government, he not only earnestly employed himself in putting forest administration in the presidency on a more sound footing, but quietly endeavoured to impress on the mind of the native administrations the desirability of protecting their jungles from further destruction by helping them in every way possible. He visited their forests at all seasons, and offered suggestions in their future management, as if to secure their attention to the important question of forest conservation; and he seemed so far convinced of the practical truths of forest science, that he left nothing undone, even at the sacrifice of personal comfort to give effect to his views.

A system of forest conservancy for the welfare of the Deccan population has now been inaugurated and rules made which, while enabling the department to preserve the tree growth on the hill slopes, tended to provide for the wants of the rural population.

NATIVE FORESTER.

Forest Re-organization in Mysore.

WE have received a recent edition of a Bangalore paper describing the re-organization of the Forest Department in Mysore.

The chief features of the new arrangements appear to be that the forests of the Hassan, Mysore, Bangalore, Tumkur, Kolar and Chitaldroog districts are to be placed under native forest officers, who will be under the immediate orders of the respective Deputy Commissioners.

These officers, while consulting and carrying out orders received from the Deputy Commissioners, will be responsible for the successful administration of the forests, and will submit their reports, returns, &c., to the government through the Deputy Commissioners, who will forward them in original with any remarks he may wish to make.

Mr. D. E. Hutchins, Assistant Conservator, is to have direct charge of the fuel plantations on the line of the Madras railway, and will also periodically inspect and report upon the forests in the abovenamed districts, and lay down instructions

for the guidance of the forest officers concerned, and will act generally as a consulting officer to the Government.

In the Bangalore district the individual forests are to be placed in charge of foresters selected from the ryot classes on small pay—Rs. 7 to Rs. 12. Forest guards are also to be taken when required from the local working population, and they will be expected to do such work as clearing the fire lines, &c. Their pay will not exceed Rs. 5 a month. In certain cases, however, where more experienced and intelligent men are required, the present foresters on higher pay will be retained, and a few of the present guards may likewise be retained. The felling operations will be conducted by the foresters abovenamed.

The forest officer in charge of the Bangalore district (Narayan Rao, probationer) will also have to supply the required quantity of fuel to the railway.

All the larger district forests, excepting the small and unimportant jungle tracts in the immediate vicinity of the villages which may be properly left to the villagers for conservancy and private use, will be amalgamated with the State forests, and the separate classification of the district forests abolished.

No unnecessary restrictions will be laid on the cutting of fuel and bamboos, except compliance with such rules as are required to promote reproduction; and it is expected that the permit system, when thus introduced, will afford a considerable revenue to the department.

In the Tumkur and Kolar districts a similar forest staff will be entertained. In some of the more important forests, however, more highly paid foresters will be retained, who will, under the orders of the Deputy Commissioners, carry out Mr. Hutchins' written orders for the proper conservancy of the forests.

In the orders issued on this subject by the Dewan to H. H. the Maharajah, attention is invited to the development of forest products, such as gall nut, soap nut, lac, tamarind, marking nut, gerupoppu nut, &c. The attention of Deputy Commissioners is also called to the necessity of maintaining the forests on the crests of the hills and about the sources and banks of streams.

The protection of fuel forests along the line of the proposed railway to Tumkur and beyond will also receive every attention.

Orders then follow on the establishment and work to be done in the Mysore, Hassan, Shimoga and Kadur districts in which the staff is to be similarly organized.

The new system when established will place the greater part of the forests under the revenue authorities. In many respects this is an advantage; it will result in all probability in the Deputy Commissioner studying and taking greater interest and pride in forest matters than under the former system, and may very likely conduce to a more efficient protection and control, more especially in such matters as protection from fire, grazing,

&c., but there are also disadvantages resulting from more frequent changes in the officers and the successive introduction of personal views and theories.

We hope that after certain forests have been set aside for the villages, the remainder will, as suggested, be brought under management as State forests and the forest rules enforced.

We are glad to see that H. H. the Maharajah has retained a forest officer of experience to draw up plans for the scientific conservancy and improvements of the State forests, and to consult on forest questions; but there is one point which is not quite clear: it would appear desirable that the forest officers should not become gradually absorbed into the establishments of the revenue officers, but should belong to a district provincial list, and, if possible, look for their appointment, promotion, &c., to one head, and not each man, to the Deputy Commissioner to whom he happens to be subordinate.

It is presumed that one of the chief objects of the change about to be introduced is a reduction of cost of establishment. It will be interesting to know whether the selection of the officers of the lower grades from the natives of the spot, with local interests, will answer; and we trust that some of the local officers will let us know by-and-bye, through the medium of the INDIAN FORESTER, how the new system works.

Flowering of the Large Bamboo.

TO THE EDITOR OF THE "INDIAN FORESTER."

SIR,—Your correspondent, writing in your April number asks for information regarding the flowering of the bamboo in the North-West Provinces and elsewhere. The following may be of interest, and if so, I would be glad to try and obtain further particulars regarding the history of the plants I refer to:—

In several of the compounds of bungalows in Amritsar, and at inspection houses on the Bari Doab Canal, there are clumps of Bamboo. In 1879 a large percentage, but not by any, means all of those in Amritsar, flowered and died. This partial flowering is no doubt due to the plants being of various ages, brought from various places, and likely enough not all of the same species.

At Kohali, on the Lahore branch of the Bari Doab Canal, one of three or four clumps of, I believe, *B. arundinacea*, flowered and died in 1880. Of the seeds which fell on the ground a good many germinated, and I saved about twenty of them, which I had transplanted to several of the neighbouring inspection houses. These have made healthy plants, and have produced shoots from two to three feet long. The clump from which these seedlings have been saved was in a position in

which it had in former years been irrigated by the canal, but it had not been watered artificially during the last three years to my certain knowledge, and probably not during the last ten years.

CHARLES TICKELL,
Assistant Engineer, B. D. Canal.

LAHORE, *May 14th*, 1881.

Flowering of the Large Bamboo at Dehra Dun.

TO THE EDITOR OF THE "INDIAN FORESTER."

SIR,—With reference to Mr. Smythies' remarks about the bamboo flowering in April 1881, I believe the larger number of individuals of four varieties, including *Bambusa arundinacea*, flowered and seeded, February—June 1880, in Pilibhit, Kheri, Bahraich, Gonda and Gorakhpur, and a large number of the remainder are now flowering. Most of the bamboos are in cultivation; in the forests we only have a patch, evidently planted years ago, in one forest in Bahraich and a few scattered specimens of the male bamboo (*Bambusa stricta*, Roxb.; *Dendrocalamus strictus*, Brandis' Forest Flora, page 569) on the edge of a high bank of sal forest in the same district. What I fancy should be done in cultivation is to collect seed and sow it for keeping up the species. In the forest patch alluded to the Inspector-General of Forests, in his late inspection of the Oudh Forests, suggested that the plot of ground in which the bamboos grow should be protected from cattle and fires, otherwise the cattle would soon eat every tender green shoot as it comes up, and then the bamboos would become extinct. The other rarities alluded to are similar to, if not the same as, *Bambusa Tulda*, an unarmed bamboo growing in Gorakhpur, and *Bambusa Balcooa* (Brandis' Forest Flora, pages 566-67). Some seeds were sown in the rains, and the seedlings were over a foot high in October; it was found that they did best when they got partial shade from neighbouring trees.

In page 7 of my Progress Report for 1879-80, I alluded to the seeding of bamboo and also to the seeding of the bamboo grass which grows in the hills. I have for the last few years always noticed in my Progress Reports the nature of the seed crop of sal; and, if other officers did the same in regard to sal or their more valuable trees, it might be useful.

Yours truly,

E. S. WOOD, *Capt.*,
Conservator of Forests, Oudh Circle.

Naini Tal, 24th June 1881.

Decay of Young Shisham Trees near Lahore.

TO THE EDITOR OF THE "INDIAN FORESTER."

SIR,—A good many Shisham trees on the canal banks near Lahore have died before they had formed any useful timber, a fungus growth having occurred round the base of their stems. I removed about 200 in one year which shewed these symptoms in a length of 10 miles. I calculate that it represented about 1 per cent. of the whole number of trees in that length, the plantations being narrow and a good deal of the distance reh and kunkur, and consequently almost bare of trees. These trees have not been irrigated since they were young plants, so that it was not due to water standing round their trunks. I would be glad to know whether a tree so attacked can be saved by any means. The fungus may be rather the effect than the cause, but I have noticed that trees on which the growth has commenced, invariably wither and die within a few months. The trees I am referring to are as nearly as I can determine 25 years old.

CHARLES TICKELL,
Assistant Engineer, B. D. Canal.

LAHORE, *May 14th*, 1881.

JJ. Official Paper.

Note on Reh or Alkali Soils and Saline Well Waters.

By Dr. Center,

Chemical Analyst to the Govt. of the N. W. Provinces.

A reference was made to this office by Government regarding the treatment of reh or saline soils by chemical manures. My predecessor, Dr. Brown, had written a report regarding the use of nitrate of lime as a remedy, and a copy of this was asked for. It could not be found in the records of the office, but I afterwards found that it had been published in the selections from the records of the office of the Financial Commissioner, and the gist of it was embodied in Powell's book on Punjab Products. As I had made numerous analyses of such efflorescences, and studied their connection with saline well waters, samples of which I had analysed from all parts of the Punjab, and as I had an opportunity of observing and learning something of similar soils known as alkali soils in the Utah Basin and other parts of America, and of the methods used to reclaim them, I beg to submit a few notes on my observations. I am indebted to Captain Ottley, of the Irrigation Department, and Mr. Miller, Secretary to the Financial Commissioner, for access to the literature on the subject in the form of reports to Government. In the valuable report of the Aligarh Committee on the action of canals and irrigation in producing or extending reh, Medlicott gives a masterly exposition of the subject from a geological point of view, and most valuable information is contributed by Messrs. Buck, Ibbetson and others who had studied the matter more from a practical point of view. I propose considering more especially the chemistry of the production of those salts and the conditions of their accumulation in soils and in the underground water—points intimately connected with each other, and equally important in the agricultural and sanitary aspects. The efflorescences consist chiefly of sodium, chloride and sulphate in varying proportions. In addition there is sometimes carbonate of soda, and I have usually found some magnesian sulphate. In certain localities the last named salt is in very considerable proportion. In other cases nitrate of lime or alkali is present.

Various theories have been started regarding the origin of these efflorescences, the oldest being probably the marine theory. According to this the Indo-Gangetic depression was considered to be an old sea bed, the soil of which became impregnated with salts from the existence of shallow "rans" and lagoons in a former geological age. In favor of this it might be mentioned that there is certain geological evidence that an Eocene sea covered the Punjab plain, its shore coinciding with some part of the outer slope of the Himalayas, with a gulf or gulfs penetrating the mountains as far as the valley of the Upper Indus. On the other hand, to the east of Kumaon and to the north of the Gangetic valley, the situation of this shore line is obscured till the Assam region is reached. The theory of recent marine impregnation is now entirely to be abandoned. It is proved beyond doubt that the whole of the materials of the Indo-Gangetic basin are fresh water alluvia to an unknown depth, and consist in fact of the debris of the Himalayas carried down by its drainage and deposited in this immense depression. There are no deep natural sections in which to observe the structure, but in the Umballa boring of 701 feet, the Calcutta boring of 481 feet, and that near Rajanpur of 464 feet, nothing but fresh water alluvia were met. We do not speak here of the Salt Range region, in which are accumulations of salt as old as the Silurian period.

Marine theory.

The true origin of reh or alkali efflorescence is the decomposition of the elements of rocks and soils which is continually going on under the action of air and water. The accumulation of the resulting salts in superficial soils or in subsoil waters depends on various conditions of chemical constitutions and permeability of soils and on the nature of the surface and subsoil drainage, which will be considered in detail.

True origin of reh.

If the rain water that runs off the surface of the hills be examined it is found to have washed out appreciable amounts of soluble salts, chiefly carbonate of lime and alkaline chloride and sulphate. If such water runs off crystalline or schistose rocks the amount of salts washed out may be extremely small,—even 2 grains per gallon as at Dalhousie. If it runs off a loose decomposing rock, the quantity may be considerable,—for example 8 grains near Murree. The rainfall that percolates the debris of the decomposed rock which covers the surface of the hill sides and fills up the channels of ravines issues in springs at lower levels, and is found to contain much greater proportions of the same salts. This water not only comes in contact with a larger quantity of degraded rock, and washes out its soluble salts, but it takes up more carbonic acid from the air in the pores of the ground, which is rich in this gas, and this dissolves more

Decomposition in hill regions.

lime and magnesian carbonate. From 10 to 25 grains per gallon are found in springs in clean soils in various hill stations. In the hill stations themselves, where the porous subsoil becomes loaded with sewage impurity from human habitation, the dissolved salts and organic impurity may be very great. For example, in the bazar well at Murree I found 35 grains per gallon, in which were 12 grains of common salt. This last is, however, a sanitary fact, and I wish at present to speak generally of the saline ingredients washed out of such soils not contaminated by human occupation.

The soluble substances produced by rock decomposition and dissolved by water are remarkably uniform in their nature, though varying in amounts, both relative and total, according to the nature of the decomposing rock soil. It may be generally stated that the earth water shews a fugitive acidity from the presence of free carbonic acid and a slight permanent alkalinity from the presence of alkaline carbonate, but that the main ingredients are carbonates of alkaline earths, chiefly of lime, and alkaline chlorides and sulphates, chiefly of soda. Other ingredients are generally in smaller amount, such as lime and magnesian chlorides or sulphates forming the permanent hardness, also silica, traces of iron, &c. Of course in special formations it may be highly charged with peculiar salts, and may even form what are called mineral springs ; but we are speaking generally of the body of water that filters from the hill sides and either sinks into the underground strata of the plains, or finds its way into the streams and rivers, and thence into the sea—the great natural reservoir of the soluble salts washed out of the earth. The waters of the Punjab rivers which I have examined, the Ravi, Jhelum and Indus, contain from 8 to 15 grains per gallon, varying according to the floods. The amount of soluble salt capable of efflorescence varies from about 2 to 4½ grains. The river waters are most concentrated when they are at the lowest. At that time they are supplied by the water that has filtered through the soil and subsoil of the higher regions, and has thus taken up more salts. In the hot weather, when the glacial water comes down, and in the rain floods at the end of the hot season, dilution is at its highest. Other glacial rivers, and those subject to annual floods, shew the same thing. For example, the total solids in Nile water vary from 9⅓ to 14½ grains per gallon.

Ultimate origin of earth salts.

To explain the ultimate origin of these salts we have to consider the action of the oxygen and carbonic acid in rain water on the rock elements. With the exception of the limestone strata, which consists of carbonate of lime, often with carbonate of magnesia, all great rock formations are composed of silica and silicates, chiefly of alumina, lime, magnesia, soda and potash, with smaller amounts of iron and other metals. Such is the con-

stitution of the granites, gneisses, slates, traps, &c. The old sedimentary rocks are similar in composition, being formed by the disintegration of these. The recent alluvia of the plains consist of finely-divided debris of the limestone and silicious groups, and in them the chemical decomposition going on under the influence of air and water is much intensified, owing to the state of fine division which favors chemical action, and because the constituents of the soil are further advanced in the path of degradation.

Origin of carbonate of lime alkaline carbonate.

In order to understand the slow chemistry going on in the ground, we have to conceive the outer shell of the earth generally covered with more or less vegetable mould, and permeated to its greatest known depth by meteoric water. There is no rock, however compact, and there is no depth to which man has penetrated, in which water is not found to have permeated by pores, cracks or fissures. The great agent of change is the carbonic acid of the air. This is dissolved in rain water, which also dissolves more from the decaying vegetable mould and from the air in the pores of the ground, which is rich in this gas. It has two great functions. It attacks the silicates of the alkalis and lime, forming carbonates. It further dissolves the carbonate of lime and enables it to be transported by water, and on its evaporation it deposits it. From the limestone rocks the water takes up carbonate of lime and magnesia which dissolve in its free carbonic acid, and in such formations it becomes very hard. The amount of carbonate of magnesia dissolved is always much less than that of lime. In the silicious rocks the felspathic family of minerals decomposes most readily. These consist of silicates of alumina and alkali, with generally small quantities of lime and magnesia. The white or soda felspar, which contains more soda than potash, is a common ingredient of the Himalayan rocks, and the decomposition of this in soils may possibly, to some extent, account for the very great excess of soda over potash salts. The chief reason, however, depends on the fact which has been experimentally verified, that in a silicate containing both potash and soda the latter is dissolved out with greater facility and in much larger quantity than the former. The process of decomposition consists in removal of the alkali by the action of carbonic acid, while water is taken up, leaving hydrous silicate of alumina or clay. The presence of alkaline water also assists in promoting the breaking up by dissolving some silica. Another group, the lime silicates, is also readily decomposed by the action of carbonic acid or alkaline carbonate, and forms an additional source of carbonate of lime. On the other hand, the talcose rocks, which contain magnesian silicate, are hardly attacked at all. This magnesian metamorphosis of rock, which is very extensive and very

ancient, is also the most permanent, and apparently a final one. We have thus accounted for the alkaline carbonate and carbonate of lime. The earth water is almost always slightly alkaline, and this plays a most important part in the decomposition of the silicious rocks and their metamorphosis. The alkaline carbonate rarely, however, appears in large amount, because it partly expends itself in decomposing silicate of lime, thus forming carbonate of lime, and if free carbonic acid is present, this will be dissolved and carried away by the water. If magnesian or lime sulphate be present, the carbonate of soda with these will produce lime or magnesian carbonate; while sulphate of soda will be found in the solution. It thus happens that the waters of the rivers contain apparently no alkaline carbonate, but show a permanent neutral reaction. All the river waters in addition to carbonate of lime, which is their chief ingredient, contain also lime, and magnesian sulphates when there has not been enough alkaline carbonate to decompose.

Origin of sulphates.

The circulation of the sulphur that occurs in the earth is very interesting. That which forms the sulphates in the earth water appears to be derived from the sulphurets, especially of iron, which are so universally diffused in rocks, and from the gypsum rocks which, however, form an insignificant portion of the strata. The sulphate of lime being moderately soluble may be readily taken up by water. The sulphurets become oxidised by the oxygen in air or water, leaving red iron oxide, which gives the yellow or red color to soils and clays; while the sulphuric acid attacks the silicates and unites with soda or lime. In the strata of the earth are found deposits of sulphates of lime, but these appear to have been deposited from solution by infiltration or by evaporation, as in the Salt Range. Their ultimate origin is probably the same as that just indicated. The presence of sulphate of lime in soils leads to the production of sulphate of soda. The former salt is slightly soluble, and as the earth water contains alkaline carbonate, mutual decomposition leads to the formation of carbonate of lime and sulphate of soda. This partly accounts for the excessive proportions of sulphate of soda often found in reh. The sulphates may be again reduced to sulphides by organic matter from the vegetable mould or other sources, which accounts for the presence of sulphuretted hydrogen in dirty well waters rich in sulphates.

Origin of chlorides.

As regards the chlorine of the alkaline chlorides, there is more difficulty. Chlorine is not an important chemical constituent of any common minerals forming rocks, but there is no rock that on being powdered and washed with distilled water does not show its presence. The only explanation known of its appearance lies in the fact that, though generally in minute quantities, it is

the most universally diffused substance we know. Even in air a chemically clean platinum wire cannot be exposed for some time without shewing the sodium lime in the spectroscope due to sodium chloride which can be extracted from the air dust.

Formation of salts in the plains.

There is next to be considered the chemistry going on in the decomposition of the debris of the rocks forming the plain. It is in a more finely-divided state, and is, therefore, in a condition more favorable for chemical action, and besides the constituents are in a further advanced state of decomposition than in the fresh rocks. The action that has been described is, therefore, intensified. It has been proved by experiment that it is from the most finely-divided clay (felspathic) particles of soils that most of the soluble substances can be extracted. These particles are so extremely fine that under the microscope they are seen only as minute dots. The other small particles which are of measureable dimensions are silicious, and yield to acids only a slight amount of soluble matter.

There are three points to be considered,—the action that takes place on the surface, that which takes place in the strata permeated by the underground water, and also the relations between the two.

Surface production of salts.

On the surface undoubtedly the greatest amount of decomposition goes on from the united action of air, moisture, heat and light. This produces the perennial supply of soluble salt necessary for the growth of plants, and in cultivation it is assisted by turning up and pulverising the soil and acting on it by water. In countries with good surface and underground drainage there is a constant escape of these salts, and the difficulty may be how to get enough of them. In many parts of our plains circumstances favor their accumulation, and the question is how to get rid of the excess. I have frequently taken samples of soil and subsoil from places where there were efflorescences and where there were none, and on washing out the soluble substances with boiled distilled water found that they were similar, but different in amounts. They always consisted chiefly of alkaline chlorides and sulphate, with often small quantities of alkaline carbonate, and frequently larger amounts of soluble magnesian salt, sulphate or chloride. Another experiment was to take a sample of reh soil and wash it repeatedly till no trace of soluble salts could be found. It was then dried and thoroughly mixed and a portion tested again to see that no soluble salt was present. It was then placed on a filter and covered with porous filter paper so as to exclude dust but allow evaporation, and the bottom of the glass filter was corked. It was frequently watered with distilled water charged with carbonic acid and exposed to the heat and

light of the sun in the hot weather for nearly three months. At the end of that time it shewed no efflorescence, but on being washed with distilled water the solution shewed the presence of considerable quantities of alkaline chlorides and sulphates. This experiment proved that in that species of soil a sensible production of reh salt may take place in a few months. A similar sample, irrigated with ordinary well water, rapidly developed an efflorescence owing to the presence of salts in the water. This is nothing particularly novel in these results. Experiments have often been made of grinding down the solid rock from the debris of which the adjoining country was formed. On washing out the powdered rock the solutions were found to contain the salts of the water of the district; indeed it is always possible to account for the composition and proportions of the ingredients in a water draining any area if the structure and composition of the rocks are known.

Approximate estimate of decomposition in soils

To estimate approximately the decomposibility of a soil, the simplest method is to dry and weigh a sample and wash out from it the soluble salt already present. On drying and weighing the residue and deducting its weight from the original there will be found the soluble salt (along with some organic matter). This is the result of decomposition already accomplished. The solution may be tested in the usual way by evaporation to find the total dissolved matter and by ignition to find organic matter. The washed residue of earth is then ignited to expel all remaining organic matter and treated with hydrochloric acid, which will decompose and dissolve the materials, which are in an easily decomposable state. The solution will contain lime, magnesia, alumina and iron, and also the alkaline basis capable of effloresceing. On deducting undissolved residue from the former, a figure will be found which will be an approximate index of the facility of decomposition of the soil. The hydrochloric acid solution can be examined in the usual way if required by first precipitating the iron, alumina and phosphates of the alkaline earths, then the lime, and afterwards separating the magnesian and alkaline bases. The last will show the salt capable of effloresceing. A more correct way is to perform an experiment similar to what I have described before with the glass funnel. A zinc box is made open at the top and closed at the bottom, with a false bottom of perforated zinc half way down. The section is usually 1 square foot. Earth is placed above the perforated zinc, and the whole is exposed to the varying conditions of the season and climate, as rainfall, heat, moisture, &c. All water that falls sinks through the perforated bottom and is collected or evaporates. After some months or a season the solution in the bottom of the box and the earth are examined in the usual way to find the results of decomposition. Such an instrument

is called a Lysimeter, and has the advantage of demonstrating the changes that take place, not by the action of acids, but by the ordinary operations of nature.

Underground production of salts.

Another source of generation and accumulation of these salts takes place in the strata moistened by the underground water. This is partly derived from percolation of rainfall from the surface where it is sufficiently porous. In its passage downwards it washes out any soluble salts it meets and carries them down till it reaches the impermeable stratum. In the second place the air contained in the vegetable mould and porous ground is rich in carbonic acid, and this is absorbed by the water and enables it to dissolve more lime and magnesian carbonate, which accounts for the much greater hardness of subsoil waters. In the third place the alkaline water charged with carbonic acid not only promotes the decomposition of the strata through which it filters, but by a constant soakage action on that which it moistens produces still more. The amount produced would be in a great measure proportional to the time the water remains in contact with the stratum. In stagnant underground waters in the middle of the plains, as at Changa Manga and Wanradaram, the dissolved salts amount to 400 grains per gallon. Another feeder of the underground water is the percolation of hill water that sinks into the porous fringe at the base of the hills. This, however, effects particularly the plain near the base of the hills. The solution formed from the debris on the hill side is much less saline than that from the finely-divided and more degraded materials of the plain. The hill percolation, therefore, effects the underground water near the hills in two ways it raises its level by hydrostatic pressure, and it makes it less saline by dilution. There is still another source of underground waters in the percolation from rivers, streams and canals. The neighbourhood of rivers affects the water level, and very sensibly influences the quality of the subsoil water. Analyses of waters taken from wells near them show that they closely approximate to the river waters, being little more than those filtered. For example, the well water near the Ravi was found to contain from 8 to 15 grains per gallon, that near the Jumna, 9·8 to 14 grains. Advantage is now being taken of this in supplying water from such wells to some large cities in the Punjab. The influence on the quality of the subsoil water, however, only exists in the khadar land or low river valley. In the bhangar or bar land, the upland that lies between neighbouring rivers, even at short distances from the valley, the water may be highly saline. In the case of canals, as far as my observation goes, there is very little percolation in the districts I have seen irrigated by the Bari Doab Canal on account both of the impermeability of the soil and the disposition of the strata. If, however, a canal were

made on a natural line of drainage, as I have heard the Western Jumna Canal is, it might influence the adjoining ground in the way I have mentioned in the case of rivers, both as to the water level and quality of percolating water.

Nature of reh and its varieties.

When rain water sinks into a soil containing soluble salts it dissolves them and carries them down till it reaches an impermeable stratum. Medlicott has pointed out the action of the first rain drops in carrying efflorescent salts down, so as to be in a great measure out of the reach of the surface scour of the succeeding rainfall. If the soil is porous it may gravitate down to the water stratum, which then becomes a reservoir of the surface salts. If it is only slightly porous, as in alluvial soils containing much clay, the soakage is only superficial to one or more feet in depth, and generally in such cases the surface soil is more or less porous from atmospheric exposure, and below it lies a more compact clay subsoil. As rain water contains free carbonic acid, it dissolves also carbonates of lime and magnesia if these be present in the soil. When evaporation succeeds it draws up the moisture in the more porous surface soil by capillary action. As the water and carbonic acid pass off, the solution becomes more concentrated and carbonate of lime is re-deposited. This last action takes place first, and as the concentrated solution is drawn up to the surface, it finally deposits its most soluble salts on drying as an efflorescence on the surface. An essential condition is the dryness of the climate. In more temperate but dry regions, as in the Utah Basin and the elevated parks or plateaus of the Rocky Mountains, efflorescences appear as well as in the scorching plains of India. The action, however, is intensified by heat, which increases evaporation. By similar capillary action the moisture will creep up the sides of objects lying on the ground, such as pieces of brick, and deposit a copious efflorescence. At first it appears in glittering crystals, but as the sodium sulphate gradually loses its water of crystallization, it breaks up into a copious white powder of anhydrous salt, and it is then that it is most apparent. The carbonate of soda behaves similarly, but the sodium chloride does not, having no water of crystallization. Nitrate of soda and lime deliquesce in damp air. During the hot months the salts if brought up by rain melt in their water of crystallization. By the word efflorescence we do not mean here what is known as such in chemical language, that is the breaking up of a crystallized salt into a powder from loss of water of crystallization. What is meant is efflorescence in the physical sense, or the appearance on the surface of the ground of soluble salts brought up by capillary evaporation. It is true that sulphate and carbonate of soda effloresce in the chemical sense, but chlorides and nitrates do not. From what has been explained regarding

the origin of the salts dissolved out of the earth, it can be understood how the solutions can naturally be divided into two groups, whether they be river and canal waters, or well waters, or solutions formed when rain water soaks a saline soil. There are first the neutral solutions from which carbonate of soda has almost or entirely disappeared, having been used up in decomposing any soluble lime or magnesian sulphate or chloride and precipitating their carbonates. To this belong the river and canal waters, the chief ingredient of which is carbonate of lime with less amounts of magnesian carbonate held in solution by free carbonic acid. There is present probably next in amount soluble salt of lime and magnesia, sulphate or chloride—the magnesia in smaller amount. The alkaline chloride, though the most constant ingredient in all waters, is in small amount, from ½ grain to 2 grains, and the alkaline sulphate in about equal or larger quantity. In the majority of well waters in the plains in my experience there is high permanent hardness, indicating lime or magnesian sulphate or chloride, and sodium carbonate is deficient. The total dissolved salts is in fresh well waters about double that in rivers and canals, and may rise in saline wells from 10 to 40 times the amounts, the increase being chiefly in carbonate of lime and alkaline chlorides and sulphates. Though we speak usually of individual salts existing in a solution, this is not strictly speaking scientifically correct. If, for example, sodium chloride and lime sulphate be made into a solution, it will really contain quantities also of sodium sulphate and lime chloride, and the amounts of the four salts will depend on the masses of the first two, temperature, concentration, &c. Properly speaking, in recording an analysis, the total amounts of acids and bases should be separately recorded. By a conventional rule, however, it is customary to arrange the salts hypothetically. The second group of waters or solutions is that containing carbonate of soda. In these there is generally little permanent hardness, or soluble lime or magnesian salt. If these two groups on evaporating produce efflorescence, in the first we may have sodium chloride and sulphate, and any magnesian sulphate, if present; in the second we may have sodium carbonate with sodium sulphate and chloride, but no lime or magnesian salt. During the process of drying, which leads to the efflorescence, the first thing that occurs is the deposition of lime and magnesian carbonate, as the free carbonic acid disappears. Subsequently, sulphate of lime being only little soluble would deposit and the highly soluble salts including sodium carbonate, chloride and sulphate, magnesium and calcium chloride and nitrate and magnesium sulphate would be capable of efflorescence. These salts, however, are not deposited, as they exist in solution as new laws come into play. The chief of these is that during evaporation the least soluble salt that can be

formed is first deposited; but this is modified by two other laws the tendency of certain compounds to form double salts, and the tendency of substances with the same crystalline form to crystallize out together. The efflorescences thus produced consist of three groups: 1*st*, the neutral, which contain no carbonate of soda, (these consist chiefly of sodium chloride and sulphate, and frequently magnesium sulphate); 2*nd*, the alkaline, which contain carbonate of soda, and alkaline chlorides and sulphates, but no lime or magnesian salt; 3*rd*, the nitrous efflorescences. These generally contain no alkaline carbonate and consist chiefly of nitrate of lime and alkaline chlorides. Others contain alkaline nitrate, chloride and sulphate. They are developed where the soil has become loaded with organic nitrogenous matter. In several places about Lahore there is a good deal of magnesian sulphate, and I have observed on twigs of farash trees a saline coating of this salt. Reh is thus not a special salt or mixture of salts, but a very variable compound. It is really the most easily soluble salt in the earth water, remaining in solution after the deposition of carbonate of lime, &c., on evaporation. The ingredients and their relative proportions are found to vary in different places, exactly as the well waters at different spots differ in saline contents, and in the same area there is a close relation between the two. The relative proportion of common salt to sodium sulphate was found by Medlicott to vary from 4 to 24 per cent.

Formation of kankar.

The re-deposit of carbonate of lime gives rise to those nodules known as kankar. It takes place at the upper margin of the impermeable subsoil. They are not formed by the lime depositing round a nucleus and pushing the other elements of the soil aside. A portion of rather porous soil, consisting of a mixture of lime, sand and clay, is infiltrated with water retained in it by an impermeable bottom. The carbonate of lime is deposited throughout this porous mass and cements its particles together till it becomes of a stony hardness. Deposit no doubt also takes place along the outer surface, as each former minute crystal deposited acts as a nucleus for further deposit. The formation is often seen in an incomplete state, nodules of soil having become only partially hardened. The process is essentially one of segregation from the soil itself. Such nodular formations, which are very common with other minerals, as iron oxide, silica, &c., are an example of the simplest kind of metamorphosis going on in rocks and soils. It is not necessarily connected with efflorescences on the surface. The essential condition of its existence is the presence of carbonate of lime or its ready production by ordinary decomposition in the soil. In soils and sub-soils which supply little lime there may be efflorescences without formation of

kankar as in those consisting of clay and silicious sand. On the other hand, in marly soils, in which there may be little production of alkaline salt, kankar may form without any efflorescence. The analysis of kankar very well illustrates their mode of formation. They show from 20 to 50 per cent. of carbonate of lime, the rest consisting of the mixture of clay and sand of which the soil is composed.

Estimation of reh in soils and water.

To estimate practically the amount of injurious reh in any soil, it should be washed with boiled distilled water and the solution evaporated, then burned to expel organic matter and finally weighed. In the case of the waters of rivers, canals and wells, they should be evaporated, ignited, re-carbonated and weighed. The easily soluble salts should then be washed out with a little distilled water and the residue weighed. The portion undissolved consists of lime and magnesian carbonates and some sulphate of lime with small amounts of silica, &c. The difference between the two weights is the amount of salt capable of effloresceing. If one have a record of the analysis of any water, a rough approximation is got by deducting from the total solids the volatile matter (almost all organic), also the removable hardness consisting of carbonate of lime. In addition two grains per gallon of carbonate of lime should be further deducted as in boiling, in order to remove carbonate of lime; two grains per gallon still remain dissolved. A still further deduction would require to be made for silica, iron, &c., but these are in small amount. I mention these methods of approximate estimation because they are readily applied and are useful for all practical purposes.

Causes of accumulation of salts.

In considering the conditions that lead to accumulation of salts on the surface or in the underground water, it is to be borne in mind that all soils exposed to moisture, air and heat are continually generating them, and that in some in which the felspathic elements are undergoing rapid decay the production may be profuse. Also all water, river, canal or underground, that has washed over or filtered through the ground, contains similar salts and promotes their further production.

Accumulation in basins.

The simplest case of accumulation is that of a closed basin like the Utah Basin. The surface water washing the salts off the ground has no escape to the sea and forms an inland salt lake. The soil in such cases is very saline, except in places where there is slope to allow thorough surface washing by rainfall, or permeability to allow the surface salt to be washed down to a deep ground water. In the centre of the depression both the surface and sub-soil and the sub-soil water are loaded with salt. The efflorescences in Utah closely resemble those in the Punjab, the main common ingredients being sulphate

of soda, common salt, and often sulphate of magnesia. In some places there is a large amount of carbonate of soda, in others borax is present. In the Caspian Basin the main ingredients are sulphate of soda and common salt. The very opposite case is a hilly or undulating country with sufficient rainfall and good natural surface drainage, the strata of which are also inclined, thus allowing of natural sub-soil drainage till the underground water finds an outlet at the outcrops of the strata or where they are laid open by natural sections of the country. Here the salts continually formed are either washed off the surface or are carried down to the sub-soil water which drains them off.

Accumulation in plains.

In examining the state of things in the Indo-Gangetic plain, it is necessary to consider the structure of the country. The Himalayan axes stretching along the north of the plain are elevated cores of granitic gneiss flanked by metamorphic and limestone rocks. To the south of this is the Sewalik fringe with its duns, consisting of clays, sandstones and conglomerates. These are fresh-water deposits formed by river and torrent action in the tertiary period, and having suffered displacement by the Himalayan elevation, they are seen to pass with great undulations and numerous fractures under the strata of the plain. This formation conducts water under the plain. There succeeds to this the recent gravel deposits from the outer hills, brought down by river and torrent action, similar to that which caused the Upper Sewaliks, and known as the Bhabar. This is extremely porous, and a great part of the water of the streams passing over it sinks into the ground and issues in springs at a lower level in the adjoining part of the plain, which is known as the Terai. Part also sinks beneath the plain and raises the ground water level. The great alluvial plain itself is composed of horizontal strata. Near the hills are gravel deposits, but further off the soil and sub-soil to an unknown depth are composed of deposits of clay, sand, and mixtures of the two in various proportions, according to the stream or lake action that deposited them. Diffused through these are found mica and small quantities of carbonate of lime, which makes soils more or less marly, and iron oxide which gives them a yellow or red color, and minuter amounts of sulphate of lime and other salts. From numerous well sections it is seen that these alternating permeable and unpermeable beds of sand and clay are not continuous, but that they thin out and are replaced horizontally by others. This is observed even at short distances. Possibly many of the sheets of clay may have more or less of a basin form. The important points for us to remark in considering the surface and sub-soil drainage are that this immense plain has an average breadth of about 200 miles; that practically the Gangetic and Punjab plains are one, the watershed

between the two being only perceptible by accurate scientific measurements; and that its length is about 1,200 miles. There are also no deep natural sections exposing outcrops of the deep strata so as to allow of escape of underground water to the sea. In consequence of the very small surface slope, and on account of the horizontal disposition of the strata over such an enormous area, the conditions as regards drainage approach to those of a basin. The surface drainage is weak, but ultimately finds its way by the rivers to the sea; but the underground drainage is usually imperceptible. As regards the production of efflorescences, we have further to consider that in the Punjab there are three belts of plain. That adjoining the hills, the submontane tract, has a plentiful rainfall and moister air; south of this is a sub-desert tract with small rainfall, and still further south is the desert country with deficient rainfall. In the submontane belt the rainfall is sufficient to scour the surface, and *as it is more permeable from the presence of gravel and sand,* and has greater slope, the surface and subsoil drainage are more efficient. In the other two tracts the working of these agencies is defective. In the hills themselves the annual rainfall of a series of years is as follows:—Murree, 56·8 inches; Dharmsala, 123·2 inches; Simla, 68·6 inches. This does not include snowfall however. In the submontane belt we would have—Rawalpindi, 32 inches; Sialkot, 39·3 inches; Gurdaspur, 33·1 inches; Hoshiarpur, 36·5. Of the less watered region there is Lahore with 19·3 inches; Shahpur, 14·5 inches; Sirsa, 14·5 inches; while about Mooltan the rainfall is 6·9 and at Dera Ismail Khan, 8·2. The simplest case to consider is that which occurs in the more desert country in which the rainfall is only enough to moisten the surface and promote decomposition. If the soil is sandy the dissolved salt is carried down to the underground water, and the accumulation takes place there. If the ground is not porous, as where clay predominates, only the upper portion is soaked, and on drying the soluble salts are brought to the surface. Instances of both these cases are found everywhere along the southern portion of the Punjab plain. In the middle portion of the plain, where the rainfall may go up to 20 inches, similar actions take place. The first drops of rainfall dissolve any efflorescence and sink into the ground, carrying it out of the reach of surface scour, which on account of the flatness of the plains and small rainfall is slight. In the more porous portions the salt is carried down to the underground water; in the more impermeable it is brought to the surface by evaporation. It thus happens that in certain places there is a scum of efflorescence on the surface while generally the ground water is saline. These remarks apply to the Doab or Bhangar land, the more elevated part of the plain lying between adjacent rivers. In this the water lies at a considerable depth from 30 to 100 or more feet, and is more or less saline; in

many places on digging deeper to another stratum fresher water is found. In the other great plains of the earth where the climate is dry and like conditions of soil prevail, similar efflorescence are developed. In the dry pampas of South America they consist chiefly of sodium sulphate with some common salt; in the Siberean steppes of sulphate of magnesia along with sulphate of soda and common salt. They are likewise found in the Russian steppes and the Thibetan plateaus. The Khadar or low-lying river valley, cut out by recent erosion from the old alluvial plain, usually shows little or no saline accumulation on the surface and none in the underground water. Here the circumstances are all different. In fact the river occupies the line of natural drainage of the country and its deposits are parallel to the line of slope. Accordingly the water percolating from the river forms a subterranean stream, gravitating down the river course and accompanying the main stream. Its extent depends on the permeability and arrangement of the strata and the resistance of the porous beds along which it moves. In the beds of dry nullahs this gravitating water may be met on digging in the dry channels. If the underground water were stagnant, remaining long in soakage contact with the water bed, it would become more or less saline, whereas it is found to resemble the river water filtered, though of course it has taken up some ingredients from the earth, chiefly more carbonate of lime. In two cases in which I examined the water in beds of dry nullahs, I found it much less saline than that of the surrounding plain. In the Khadar land the water lies near the surface, and may be within the reach of capillary evaporation, which would produce efflorescences, as it often does to some extent. But in consequence of the occasional washing by floods, and of the underground circulation I have described, there is no permanent accumulation either on the surface or in the ground water.

Accumulation by evaporation from a shallow water table.

One of the most interesting and important cases is that in which the ground water lies close to the surface within the reach of capillary evaporation, thus furnishing an unlimited supply of efflorescence. The enquiry made by the Aligarh Committee chiefly referred to this instance. It was considered that the ground water level had been raised by percolation from the canal assisted by hydrostatic pressure in consequence of the canal being above the level of the country. Other causes assigned for the rise were the obstruction to surface drainage by canal and railway embankments acting as bunds, and the practice of profuse irrigation in flooding. All these would lead to an increased body of water sinking into the ground, carrying earth salts in solution to be again brought up by capillary evaporation from the shallow water table. It is very important to be able to estimate how much is due to each of

these agencies, as on the decision of this point would depend the remedial measures to be applied, such as the lowering the level of the canals, their realignment on the high Bhangar land instead of on the lower ground, the restriction of profuse irrigation, the relieving of the surface drainage, and the establishment of artificial sub-soil drainage. I am unable to enter into the merits of these most interesting points because I have never had an opportunity of making observations in an area where this mode of generation of reh was going on to a serious extent. The only portions of country I have seen in which the ground water lies very near the surface are the plains adjoining the hills and the Khadar lands or river valleys. In the former the rainfall is more plentiful, the slope of the surface and deep strata are better, there is more moisture in the air, and therefore less evaporation. All these tend to prevent accumulation of salt below and efflorescence above. In the latter the washing of the surface by the floods and better subterranean drainage may account for the want of accumulation. In the parts of the Bari Doab Canal which I have seen the ground water lies at a depth that is totally out of the range of capillary action, and the strata consisting of alternating clays and sands are so impenetrable that percolation can have little effect on the water level. Captain Ottley informs me that on the Bari Doab and Upper Sutlej Inundation Canals the curves of the rise and fall of the well waters markedly follow those of the rainfall and do not appear to be affected by irrigation. I did not find any marked difference in the water levels of the wells near and at a distance from the canal about Lahore. A still better proof was that the salinity of the wells was not altered by proximity to the canal. If percolation to any extent existed, the wells close to the canal ought to be fresher than those at a distance. In the part of Lahore occupied by the railway station and barracks the ground water is salt. At the end of the hot weather I found that a well, a few yards from the canal, contained as much salt as others far off. After the rains the same well waters were found to be so diluted as to contain less than one-half of the former amounts. The depth from which capillary evaporation can take place is also a question that ought to be investigated by observation and experiment. Much of course depends on the porosity of the soil, but in the most favourable cases one would fancy from the known laws of capillary force that the action would only be through a few feet, unless assisted by hydrostatic pressure. At the village of Baoli, on the Western Jumna Canal, where the reh action is very pronounced, the depth from the surface of the ground to the water table (as shown by measurements of an unused well) is 8 feet. It is said that before the Western Jumna Canal was reopened in 1819 the water in wells about the part lay at a depth of 60 to 70 cubits, and this tradition

appears to be confirmed by inspection of the records of other wells which had been sunk to as much as 116 feet, and in which now there are 62 feet of water. On the banks of water-courses and canals about Lahore in salt soils one often observes two lines of efflorescence—one a few feet above the water level at the upper limit of capillary soakage, and another some distance from the surface, at the base of the surface percolation. As regards the rise in the well water levels, said to be caused by canals, it would be necessary to have accurate information as to what those levels were before the canals were made. Probably no accurate record was made before the earlier canals were started, as attention was not directed to the point.

Other modes of accumulation.

There are last to be noticed some other modes of distribution and accumulation of alkali salts. Irrigation by flooding and allowing the water to dry on the soil, unless it is very permeable, of necessity leads to production of salt. Not only does the irrigating water contain salt which it deposits as an efflorescence, but it also promotes further decomposition in the soil. The amount of reh in ordinary canal water might be from 2 to 6 grains per gallon. If well water is used the accumulation is much greater, because it contains much more salt. In places where the water is sweet, the reh may be about 6 to 15 grains per gallon; where it is salt, it may amount to more than 200 grains per gallon, as at various places on the railway line between Lahore and Mooltan. An extraordinary instance is mentioned in the Aligarh Report of a reh soil tried by the most energetic measures without effect. An analysis of this soil would probably have proved that the elements of the soil itself were in such a state of decomposition that most of the measures employed assisted the process. Again, water running off a saline field must necessarily dissolve a portion of its salt, and if it be allowed to run into another and dry, that salt will be deposited. The agency of wind appears to be a slight and very variable one. There is no doubt that wind blowing over a saline country and raising dust transports saline particles. Travellers over the alkali plateaus of the Rocky Mountains are familiar with the irritation caused to the eyes by this mode of transport. All these, however, are of secondary importance. The main points to bear in mind are, that there are several factors causing production and accumulation, and others leading to the removal of earth salts. Of the former there is first the soil itself. This is always generating them, and in certain cases its materials so readily undergo decomposition that perhaps even artificial means may fail to cure the evil. The next chief factor is the water used in irrigation. This always contains reh salts,—the river and canal water in small amount, but the well water often in enormous

quantities. In addition, the irrigation water may not only deposit its salt in the soil, but it causes further production in the soil itself. Another cause is the special condition in which the subsoil water lies within the reach of capillary action from the surface, which may give rise to an inexhaustible supply. The factors concerned in the removal are, first, permeability of the soil, which may allow the salts to be washed down to the underground water. If this have a ready outlet, they are removed; if not, there will be a saline ground water; but the surface may shew no accumulation if the water table is deep. If, however, the ground water is a very short distance from the surface, there may be a profuse efflorescence. The second great cause of removal is surface scour. If the rainfall is copious it may thoroughly wash off excess of salts, and for this reason in rainy regions alkali is rare. If it is slight and only moistens the soil without scouring it, there will be a continuous production and accumulation on the surface, except when the soil is porous and allows it to be carried down to the ground water. The third means of removal is by vegetation, which annually takes up its necessary portion of salts and assimilates them. It is frequently observed that in cultivated spots the reh is kept under; while the uncultivated ground around may be covered with it. In connection with this it is to be remarked that for land plants potash salts are necessary, but it is doubted whether soda salts are essential, except in the case of Salsolæ, &c., which grow in soda soils. This may have something to say to the barrenness of our soda reh soils. Another factor to be noticed is the effect of shade produced by vegetation, which prevents the excessive evaporation which brings the salt to the surface. It thus remains more diffused through the moisture in the soil. Lastly, plants also induce capillary currents towards themselves. The absorbing parts are the rootlets and myriads of hairs surrounding each. These, by the act of absorption, set up capillary currents in the moisture of the soil towards themselves, which compete with capillary evaporation at the surface and tend to the diffusion of the moisture and its salts through the soil as far as the roots extend. It is to be noted that if a soil remain damp, so that the salts are diffused through it, they may do no harm. It is their concentration as a scum on the surface that poisons crops. The moisture round the rootlets forms a solution so saline that the osmose currents by which the plants are nourished are interfered with and they perish.

Methods of cure.

I conclude this paper with some practical remarks regarding the methods of dealing with saline efflorescence agriculturally; but these I wish to be considered suggestive more than anything else, as I cannot pretend to any experience in that line. When visiting Utah I was very much struck on finding that the saline efflor-

escences of that basin were similar in nature to those I had seen and studied in India. I made enquiries into the ideas current on the subject and the methods of reclaiming the soils. Brigham Young's notions of natural philosophy were both extremely simple and at the same time shrewd, as would be expected from an uneducated but practical and successful man. He said: "There is salt in every thing. Water has salt, plants have salt, and earth has salt; and the Bible tells us that if the earth have lost its salt it is useless. A certain quantity of salt is necessary for vegetation; in our country we have too much of it, and we get rid of part of it." He referred me to Mr. Woodruff, who was Secretary to the Agricultural Society, and to some of the best farmers, to see what was done. The plans adopted were the following:—A salt field was ploughed and small runlets of fresh water were sent down the field, at short distances apart, washing the soil and running off into the drainage of the country. Another method was to plough up a field and make a terrace round it and then flood it. The water was allowed to soak for some time till it had dissolved the salt and was then run off. Another plan was to terrace a ploughed field and dig a deep trench round it. The field was flooded, and, the unploughed subsoil being less permeable, the water holding the salt in solution filtered into the trench. I observed similar processes carried out on the salt marshes round the Bay of San Francisco. This is gradually silting up, and surrounding it are miles of low flats impregnated with sea salt and growing only saline plants. Through these pass shallow delta channels, scoured by the rise and fall of the tide. To reclaim this soil, low earth embankments are raised round the farms. These are fitted with floodgates closed by the rise of the tide and opening on its fall. The salt in the soil is washed out by the fresh water of the streams falling into the bay by a process of sluicing, such as I have described, and is run off as the tide falls. In the depression between the coast range and the second range of hills artesian wells can be made, and these were used where none of the mountain streams were available. An English Company was working on a salt marsh by the aid of artesian water only; but it was generally considered that it would not be a success, as the amount of artesian water was after all only trifling compared with the area to be reclaimed. The universal opinion in Utah was that if they once succeeded in covering an alkali field with a crop of any kind the victory was won. After the land was half cured, they generally covered it with a hardy grass, the most approved being red top American grass. Beetroot was also said to grow well as an early crop; after that Indian corn and other crops by degrees. Tuberous crops

By sluicing and irrigation.

By manure and cultivation.

grow well in the country, and the potatoes are said to be the best in the world. The last method I shall mention was that employed by Brother Fenton, an energetic Devonshire farmer. It happened to be impossible for him to get fresh water to wash the salt out of his fields, and he tried large quantities of manure,—20 to 50 tons per acre. Barn yard manure was considered the best, and, as his great object was to keep the surface from the sun, which drew up the salt, he also used litter to cover it. The first crops he covered the ground with were the red top grass and oats, and he sowed his crops in September, so that the ground should be covered with vegetation when the alkali would be appearing. As soon as by this means he got his first crop of red Timothy grass he found he had succeeded. Mr. Fenton complained that after partly curing one field he ruined it by trenching and bringing up a saline subsoil. His idea was that the salt was a sort of perspiration of the earth, and, therefore, mostly on the surface, and that by turning up the subsoil he would get a better soil. In India it is certainly the case that a short distance below the surface less reh is found. It may be different in a closed basin like that of Utah, where the subsoil also may become saturated with salt. Utah city is partly situated on a bench at the base of the Wasatch hills adjoining the plain, and at first the farms surrounding it were made on the ground that was not saline. About one-fourth of the land under cultivation was salt, and three-fourths of this had been cured by sheer cultivation, much in the way I have described in the case of Mr. Fenton's farm. For the other fourth sluicing and irrigation had been available. The cultivation of saline soils is also carried out in other settlements. In most old settled countries—and especially in India—agriculturists are very conservative in following the practices of their forefathers. In America, where the population is composed of emigrants from all countries, every man brings the methods used in his own, and all sorts of trials are made and the fittest survives. These are made in a new country under new circumstances, and people are not bound by traditional customs, but are anxious to try whatever succeeds in the hands of others, and also make experiments according to their own ideas. These may be crude, but still a vast number of experiments are made,—not isolated ones by a Government, but everywhere generally by the people themselves—and anything that is successful is hailed as a discovery. Some of the methods I have described as used in America may not always be practicable in the plains of India. To run off the saline water requires a slope and lines of natural drainage that may not be available. It might be possible to run off the salt-impregnated water into absorption wells, thus returning the salt to its natural destination, the

underground water. It is a law that a well will absorb as much water without raising its level as it would give out without sensibly lowering it. This means has been used in some cases to get rid of liquid sewage, but was found to poison the wells. The plantation of trees is also proved to be a very efficient means of cure. The kikar is well known as capable of flourishing in such soils. They not only assist in moderating excessive evaporation by shade, but they also absorb and remove a certain amount of salt from the soil. As the alkali exists chiefly in the surface soil and in much less amount at a small depth, trees may grow readily where annual crops could not. The latter have their rootlets only in the surface soil, and are poisoned by the excess of salt; while the roots of trees extend deeper into less saline ground; also plants not only consume portion of the salt, but they prevent its concentration on the surface. A most conclusive experiment made near the Western Jumna Canal by the Irrigation Department is reported by Colonel Fulton. A piece of utterly useless reh land, for which revenue was remitted, was taken up by the Department and planted with kikar trees. These flourished and a very fine crop of doab grass, two feet high, came annually up under the trees, and the efflorescence disappeared. The villagers, seeing that the land was improved, and fearing it would be alienated by the new settlement, applied for the restoration of both trees and land, and carried their point in the courts of law. A few days after the restoration the wood was sold to a wood merchant and every tree cut down. At present the doab grass is all gone, and the soil is encrusted with salt. Such an experiment made among American farmers would have excited the keenest interest and given rise to numerous trials of the same.

By arboriculture.

The method of cure by nitrate of lime as a manure, suggested by Dr. Brown, would act in two ways—it would partly serve as a manure favoring vegetation, and in addition it would act on the alkaline and magnesian sulphate by double decomposition, producing nitrate of alkali and sulphate of lime, which last is a slightly soluble salt which is not hurtful to vegetation and would not form an efflorescence. Carbonate of soda would be similarly neutralised, but the sodium chloride would remain unaltered. The natives are well acquainted with this use of nitrous efflorescences, which can be distinguished from the sulphate of soda by its moistness due to deliquescence and by the brown color and by not effloresing in fine powder. It consists mainly of common salt and nitrates of lime and soda. This production of nitrate is due to the decomposition of nitrogenous animal or vegetable matter, first producing ammonia which is afterwards oxidised to nitric acid. An essential condition of the nitrification process is the presence of alkaline

Chemical manure.

carbonate or carbonate of lime to fix the nitric acid. For example, ordinary dung heaps may produce plentiful supplies of ammonia, but no nitric acid. Indeed, nitric acid, if present, is changed by the reducing action of the decomposing organic matter to ammonia. If wood ashes containing carbonate of potash or lime be mixed with the heap, the acid becomes fixed. Artificial nitre beds, called *nitrieres* or nitre plantations, were first introduced by the chemists of France to supply nitre for gunpowder during the wars of the Revolution, when the ports of France were blockaded by the English and imports prevented. Animal manure is mixed with carbonate of lime and wood ashes, and frequently watered with urine, which produces much ammonia. This is cultivated for two or three years. In tropical countries the production of nitrates is more plentiful and rapid. A manure of a valuable quality could probably be made by municipalities or by the zemindars themselves by mixing pounded kankar, or even marly soil with manure, and moistening it frequently during one or two hot seasons. If it were moistened with liquid sewage, which would tend to produce more ammonia, the production would be increased. This artificial production is an exact imitation of what takes place naturally in soils in which nitre is produced. In the Punjab nitrates effloresce near villages where the soil becomes impregnated with animal sewage, which undergoes nitrification in presence of the carbonate of lime and alkaline carbonate in the soil. The most plentiful supply is in the soil on the mounds that indicate the sites of old villages. This is the main source of the manufacture of saltpetre in the Punjab. Similarly near buffalo ponds and watering-places for cattle, where dung is trodden into the soil, nitrates effloresce and are swept up by the zemindars as manure. A similar process, no doubt, takes place when a field is well manured with animal refuse. The conditions of the production of nitrate of lime in the soil are present, and thus may account to some extent for the reclamation of alkali soils by manuring alone. For this purpose animal manures would be far superior to vegetable. In plants there is comparatively little nitrogenous matter, which alone can generate nitrates or ammonia. In Utah a favorite manure is the refuse of slaughter-houses, which would be capable of supplying large amounts of ammonia and nitrates.

As regards the uses to which the alkali efflorescence might be put, sulphate of soda can easily be separated by evaporation and forms a useful purgative. It might be possible to utilize those more rich in alkaline sulphate for the manufacture of carbonate of soda for glass or soap work. The average mixture of sodium chloride and sodium sulphate resembles the product of the first step of manufacture of this carbonate, which is done by the addition of sulphuric acid to common salt. By evaporation the sulphate which crystallizes out first can be

freed from most of the common salt, and this would resemble the salt cake. The materials for the further reduction, charcoal and lime, would be readily available, the latter from the kankar beds. Certain soils contain carbonate of soda in such quantities that it can readily be separated by the crystallization process. At one time an enquiry was made as to whether the nitre manufacturers defrauded the revenue to any extent by disposing of the alimentary salt left in the refuse saltpetre earth after extracting the nitre. Samples have from time to time been forwarded to this office, and these were found to contain from 35 to 70 per cent. of common salt. It would certainly be possible and not very difficult to obtain a rather impure alimentary salt by rough crystallization processes not only from the saltpetre earth but also from suitable kinds of reh.

V. Notes, Queries and Extracts.

Sticks used in producing fire by friction.—The following extract from a paper read by Mr. V. Ball before the Asiatic Society of Calcutta may perhaps elicit from our readers some further information on the same subject. It is probable that the plant referred to is the common climber found usually in sâl forests—*Smilax ovalifolia* :—

"Some years ago I exhibited a sample of the fire sticks used by the inhabitants of the Nicobar Island. These were cut from some soft white wood, possibly from a species of Bombax. Subsequently, in Sambalpur, I found that the inhabitants of the jungles there knew how to make fire in exactly the same way, the sticks used being either of the small solid bamboo or the branches of the pothur tree (*Croton oblongifolius*). In this case my attention was drawn to the fact by finding sticks which had been so used cast away in the jungles.

On asking the coolies with me whether they understood the art, they immediately set to work in the following manner :—

Breaking off two pieces of dry bamboo which had about twice the diameter of an ordinary lead pencil, they pointed one of them at one end, and on the side of the other they made a small pit to receive the point; from the pit a groove or notch was cut across on the side of the stick. This second stick being placed horizontally in position on some dry grass and leaves, was held there by the toes of the principal operator who squatted down for the purpose.

Taking the first stick between the palms of his hands and placing the point in the pit, by rubbing his palms together the stick was made to revolve backwards and forwards, and the second operator relieved the first by commencing at the top as the other worked down to the bottom. They continued thus, alternately relieving one another, till, in an incredibly short space of time, the pit became charred and soon began to smoke, the fine dust resulting from the friction falling down. The already mentioned slit formed a small pile on the tinder and caught the first spark. This being carefully nursed and blown upon, soon burst into a flame.

At the ethnological section of the British Association Meeting in 1878, I exhibited and described some of these sticks, and the communication appeared to excite a considerable degree of interest. This—added to the fact that I found that even in India many people are not aware that the knowledge of how to

produce fire with two small sticks, so far from being extinct, is probably universal throughout some wide tracts in this country—has led me to make further enquiries. On the only two occasions upon which I have been in the jungle this year I have asked the first regularly jungly men I met with whether they could make fire. Both replied in the affirmative, and made good their words by producing a flame in a very short space of time. The first case happened not many miles distant from Deoghur. Here the sticks used were the already mentioned pothur (*Croton oblongifolius*): these are now exhibited. The second case occurred in the centre of the Kharakpur Hills where I came across a tribe of people called Naya. Their headman, who, by the way, was a most curious and amusing individual, on being asked to produce fire sent one of his companions for the sticks to the jungle close by.

He returned, not with the pothur, but with the woody stems of a thorny creeper. The thorns having been removed, a pit was made at a node or joint, and then, in the usual way, a very few turns produced a spark. These sticks I also now exhibit. This creeper has three native names—Kumari (or Kumree), Dahnee, and Maskanti. Although I omitted to get leaves or flowers, I am fully satisfied that it is a species of the genus Smilax, and in this opinion Dr. Feistmantel agrees with me. Most of the common species of Smilax have scarcely got woody stems, and in this one it is noteworthy that the wood much more closely resembles that of an *endogenous* than that of an exogenous plant.

So anomalous are the characters of the genus that Lindley long ago proposed a special class, the *Dictyogens*, for its reception. Among its anomalous characters I do not know whether its woody structure has been specially noticed.

There is every probability that this Smilax was the so-called vine which was known to the ancients as affording the wood with which fire was produced."

THE following telegram from Mr. J. Wood-Mason to the Chief Commissioner of Assam, and dated June 8th, 1881, is extracted from the *Assam Gazette*:—

TEA-BUG.—Have discovered by observation of specimens of this formidable pest kept in confinement that the female deposits her eggs singly in the substance of the tenderest shoots of the plant in the *internodes* or portions of the stem between the pekoe and the two or three leaves succeeding from above downwards, and in the buds developed in the axils of plucked leaves and in the parts thereabout; that the presence and position of each egg is from the first indicated on the exterior by two unequally long glistening white bristle-like prolongations of its shell, and later by discolouration of the point pierced. Have

discovered by dissection that she is provided with a serrated ovipositor of the shape and sharpness of a sabre, wherewith to pierce holes in the soft tissues of the plant for the reception of her eggs. These observations have been verified in the field upon numerous blighted bushes; but, though eggs have readily been found by the unaided eye on blighted portions of bushes, not a single one has yet been seen on any perfectly uninjured shoot. The vigorous and unremitting plucking of the blighted portions of bushes might mitigate the evil, and I would suggest that this message be sent to newspapers, and published in the *Gazette* for general information.

We regret to have to record the death, since our last issue, of Mr. R. S. Dodsworth, Deputy Conservator of Forests. Mr. Dodsworth had passed most of his service in Oudh where his work in the organization of the admirable roads and compartment lines of the Oudh forests, and the protection and working of the sâl forests, is well known. He had, soon after his return from leave, been transferred to Chittagong, where, however, he was destined to remain only a few weeks. Being attacked by fever at Rangamati, he had to be removed to Calcutta, and thence proceeded to Fatehgarh where he died on the 19th March. His numerous friends in the department will much regret the loss it has sustained.

The Moreton Bay Chestnut in the Darjeeling Terai.—Sir,—The plants of the Moreton Bay Chestnut (*Castanospermum australe*) at Bamanpokri (Darjeeling Terai), three in number, have this year flowered for the first time.

I send you a bunch of flowers herewith. They grow like the jack fruit, on small special branchlets on the older parts of the stem and branches; but these special branchlets seem to produce no leaves.

I would have sent you a better specimen, but that I want to procure seed in order to raise more seedlings of the tree.

Two of the trees which are closest to the teak plantation, and are thus in the shade, seem to be dying slowly; whereas the other, which is about 60 feet distant, but well exposed to air and sunlight, is in a flourishing condition.

At page 34 of your list of "Trees, Shrubs, &c.," you state that 1869 is probably the date on which these trees were planted. I should be glad to know if in its native habitat the *Castonospermum australe* flowers at so early an age as eleven or twelve years. I fear this early flowering is an indication that the tree is unable to adapt itself to the climate of the Terai.—F. B. M.

Note.—It is a handsome orange yellow flower, resembling that of 'Cassia.' We cannot say whether flowering at an early age is the characteristic of the tree. Perhaps some of our readers can help us.—Ed.

SOME experiments are to be made in Burmah, as well as at Sitapahar in Chittagong, and at Bamunpokri in the Darjeeling Terai, in raising seedlings of *Broussonetia papyrifera*. I notice at page 352 of the INDIAN FORESTER for April 1881 that in Japan it is said to thrive best on dry sunny slopes, and is propagated by cuttings. I should be glad to know how the seeds should be sown, for it is from seed that I must grow it at Bamunpokri. Nothing is said in the Forest Flora (Brandis') as to the mode of rearing it, except that it is hardy, and seems to accommodate itself readily to different conditions of climate.

Under what conditions of climate can it best be cultivated for paper stock?

The Japanese, it would seem, make the most use of it. Is there no information available beyond the fact that "it thrives best on dry sunny slopes?"

In 1873 the Japanese sent to the Vienna Exhibition a number of articles manufactured from the paper of *Broussonetia papyrifera*. At page 145 of the *Revue des Eaux et Forêts* for May 1875, some information is given, which is derived from a report submitted to the Society of German Orientalists by Messrs. Zappe. Here it is said that propagation is by means of *root-cuttings* about five inches long, and about two-thirds of an inch is allowed to protrude above ground.

The Japanese employ *Edgeworthia papyrifera* in the same way as *Broussonetia papyrifera*. This is probably the same as *Daphne papyracea*, Wall—(see page 386, Brandis' Forest Flora)—which is common in the forests of the Darjeeling district above 6,000 feet altitude. Can this be taken as any indication of the locality likely to be suitable for the cultivation in this district of *Broussonetia papyrifera?*

This latter grows well in Central France, and multiplies there with wonderful facility. I sowed a few seeds here, (about 5,500 feet altitude), on the 1st of May, but as yet (11th May) they have not germinated.—F. B. M.

DAPHNE PAPYRACEA AND EDGEWORTHIA GARDNERI are both common shrubs in Nepal, both extending into Darjeeling, though the latter is somewhat rare, and both used for making country paper.

From the fact that *Broussonetia papyrifera* is indigenous in the Martaban Hills—(see Kurz' Flora of British Burmah, II, 487)—we should say that it should do well enough at both Bamunpokri and Sitapahar. At the latter place, the seed is germinating well.—*Ed.*

NEW RAINGUAGE FOR REGISTERING LONG PERIODS.—At the April Meeting of the Asiatic Society of Calcutta, Mr. H. F. Blanford, F.R.S., described a rainguage with evapometer for remote stations, which is the invention of Mr. D. F. Hutchins, of the Mysore Forest Department, as follows:—

"The gauge only differed from an ordinary raingauge in having a very large receiver, capable of holding about 30 inches of rainfall. The receiver was surrounded by an outer casting to diminish evaporation, and, in use, was buried in

the ground level. Accompanying it was a smaller vessel of the same diameter, but much shallower, and covered with a conical lid having a small perforation at the apex, which was protected by a small conical cap, to prevent the entrance of rain. This served as an evapometer. In use a measured quantity of water (say two inches of rainfall) was placed in both vessel, and they were then left undisturbed for a month. At the end of that time, the quantity in each vessel was remeasured. The additional water in the gauge being added to the loss in the evapometer was assumed to be the total rainfall of the interval.

"A year's verification at Alipore, where the rainfall was also measured daily, showed that the instrument was less accurate than had been hoped, but was nevertheless calculated to give an approximate result when great accuracy was not important. It had been found that the evaporation from the evapometer exceeded that from the gauge by quantities varying from ¼ inch to ¾ inch in different months, and the total error in ten months amounted to 4½ inches. The cause of error being obvious, it appeared probable that it might be greatly reduced, or even corrected, by increasing the depth of the evapometer, and by enlarging the conical cap, which would diminish the evaporation."

Such an instrument will be invaluable for forest localities visited, say, once a week or even once a month by the ranger, and we hope to hear that is has been so perfected that the errors are reduced to a minimum, and it may be possible to utilize it for gauging the rainfall of forest reserves, and experimenting on the differences within and outside the forests.

Decay of Eucalyptus at Changa Manga.—I see that Mr. J. C. McDonell draws attention to the destruction of Eucalyptus at Changa Manga Plantation. It is a pity that he does not state what species have suffered, or whether only one kind has been affected. I was reading lately a paper "On the Timber-supply of Australia" by the Hon'ble Mr. Krichauff. He says:—"I heard at different times the gum trees died without any apparent cause in many parts of the colony, especially in the south-east. I observed once, many years ago, that our blue gums died suddenly over an area of perhaps fifteen or twenty acres, in the Bugle Ranges in the midst of a well-wooded district. Last summer, however, my attention was called to the following alarming fact:—On a very large tract of timbered country on the Hundred of Strathalbyn, said to be about fifteen or twenty square miles in extent, not a blue gum remained alive. All other gums—white, yellow or red—were luxuriant, while the blue gums, from the largest tree to the smallest sapling, were dry, and the bark, already cracked, ready to fall down this winter. It was remarkable and perplexing to observe the exactly straight boundary line

on one of the outskirits of this tract of land which I visited. Within a few yards all blue gums were dead, and outside the line they were as vigorous as ever. My time being short, I could not examine the trees properly to ascertain anything further; but such an examination ought yet to be made. At all events, inexplicable as it is to me, I thought it right to mention it, so that one or other of my hearers or readers may venture an explanation, or the enigma may be solved by comparing the observations of a number of persons at different localities and times, and perhaps as regards different kinds of trees."

In the instance quoted it is the blue gum (*Eucalyptus Globulus*) which alone suffered. Was it also this species at Changa Manga?

Above, the blue gums were growing in their native climate along with their accustomed associates; the blue gums suffered but the others flourished. The cause might have been supposed to be frost or drought, but that blue gums were said to be unaffected on the other side of a boundary line.

Again, one would expect that, if the cause were drought, the older trees with roots penetrating more deeply would have resisted longer than young saplings. The other trees, too, even though of hardier constitution, would have probably suffered to some extent.

Thus, though without the opportunity of observing the facts, it is rash to hazard an explanation. I should imagine that the damage was caused by an inroad of animals, perhaps rats and mice, or other rodents. I should examine the roots of a tree that had shown signs of suffering, to see if it had been gnawed, and also search for any other indications of the presence of animals, such as their holes, droppings, &c. Or the evil might be due to fungus; and perhaps this is more in accordance with the fact of the boundary line separating the invaded tract from the flourishing tract alongside. The intervening few yards of cleared land forming the boundary line might readily be crossed by such animals as rats and mice, but the mycelium of fungus would take some time to cross it, or be stopped for want of nourishment.

White ants are generally credited with forbearing any living tree, and besides they are certainly not exclusively partial to blue gum. So I think we must seek the cause of death in some peculiarity of the species. The malady may have attacked other vital parts, for instance the cambium; but the roots, I think, are most vital—the most likely seat of the evil.

The *Revue des Eaux et Forêts* for November 1880 contains an interesting paper on the "Maladie ronde" which ravages the pine forests in Sologne. The writer comes to the conclusion that the malady, which attacks the Maritime and Scotch pines, is due to the mycelium of certain fungi, notably the *Rhizina undulata* (Fries.)—F. B. M.

FRANCISCO SOUBEIRO, Conducteur Forestier, notifies, in an article published by the official journal of agriculture in Portugal, a new property of the wood of the *E. Globulus* discovered from experiments made while directing the works of the port of Figueria de Foz. M. Soubeiro feels certain that the "teredo" does not attack the Eucalyptus. If this observation is confirmed, engineers will not fail to make use of it for they have actually no efficacious means of protecting from the ravages of teredo the ordinary timbers employed in marine construction.—(*Revue des Eaux et Forêts.*)

WE see from the Review of Revenue Administration in the Punjab for 1879-80, published in the *Punjab Gazette*, that the Lieutenant-Governor complains that no mention is made of the "Chos" of the Sewalik Range, and directs this subject to be noticed every year in the Financial Commissioner's Report.

It appears that the action of Punjab rivers in 1879-80 caused a loss of Rs. 42,295 to Government, chiefly in Bannu and Muzaffargarh.

PAPER PULP FROM WOOD.—The following interesting description of the process of making wood pulp is from an account of the opening of the Thorold Pulp Paper Company's establishment published by the *Thorold Post*, Canada :—

"The wood, four feet in length and of any thickness, is brought in at the basement, placed in the barking-jack (one stick at a time), where two men with drawn knives rapidly peel off the bark. It is then conveyed by the elevator to the first floor, sawn in two-foot lengths with cross-cut saws, passed on to the rip saw, where it is slabbed (that is, a small portion of wood on opposite sides taken off), to permit it resting firmly in the grinding engine. It is then passed to the boring machine (an upright one and a half-inch auger, with foot attachment driven by power), where the knots are bored out. The wood is then placed in racks of the same size as the receptacle in the grinding engine and carried out to be ground. The grinding engines are upright, and receive at a filling one-twentieth of a cord of wood. The wood is placed in a receptacle, and by a simple, variable, automatic process is pressed flatwise between two outward revolving rolls, composed of solid emery, which are flooded with a spray of water, carrying off the fibrilized pulp in a stream through revolving screens to the tank or stuff-chest in the basement. It is then pumped up into a vat that forms part of the wet machine. In this vat is constantly revolving a large cylinder faced with fine brass wirecloth, which picks up the particles of pulp out of the water and places them on the felt (an endless piece of woollen goods which makes between rolls, for different purposes, a continual circuit of the wet machine). On the cylinder is

turning a heavy roll, called the concha; between the two, where they met, the cylinder leaves the pulp, with most of the water pressed from it. The pulp now makes its appearance on the felt above the concha roll in a beautiful sheet, 38 inch in width, and is carried along in a steady flow a distance of about 8 feet, where it passes between (the water here again being pressed from it) but not beyond two heavy rolls, the upper iron, the lower wood, it adheres to the upper roll, which is constantly turning, wrapping it up, and when a sufficient thickness is attained, is cut off by a knife being pressed to the roll attached to the machine for that purpose. It now leaves the roll in a thick, white sheet, 36 × 38 inch, which is received by the boy in attendance on a table conveniently attached to the machine, and folded into sheets 14 × 26 inch. It is then placed on scales until the weight is 100lbs., when it is placed in the press and firmly tied into square compact bundles. It is now ready for shipment to the paper mill to be made into printing and tea paper. The wood paper pulp has been placed in the market, and found a ready sale. Last week a contract to the amount of 1,000 dols. was made with one of our large paper mills."—*Timber Trades' Journal.*

I HAVE lately noticed that young Singoli seedlings (*Cinnamomum Tamala* and *obtusifolium*) are most frequently to be found in sheltered spots as under the escarped banks at the side of a road skirting sidelong ground. This I noticed on the *zig*-zags of the old military road just above Kurseong bazar, Darjeeling; a clump of bramble-bushes or an overhanging bank being sufficient shelter to secure the growth of these young saplings. In the interior of the forest they are also generally found under the shelter of a boulder stone or in some pit or hollow, such as is caused by the up-rooting of a large tree.

Whether these situations are preferred as affording shelter for the young plants, unable to survive without it, or as giving the proper conditions for the germination of the seeds, I have not been able to judge. But I have found in so many cases that seeds which are perfectly good, require special conditions to ensure germination, that I incline to the latter opinion.

The Toon (*Cedrela Toona*), India Rubber (*Ficus elastica*), Lampatia (*Duabanga sonneratioides*), Chilauni (*Schima Wallichii*)—all important trees in this locality, British Sikhim—have each their peculiarity in this respect; and I hope that some of your readers will record their observations on matters of this kind. The Singoli is not perhaps an important tree; but there is no doubt that it will be a great saving of time and money to know how different kinds of trees spring up from seed in the forests, before attempting to raise them in nurseries for planting.—F. B. M.

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The Forest School at Dehra Dún.

Most of the readers of the "Forester" are aware that the first course of theoretical instruction at the above mentioned school is now in progress; and it will be useful to give to all those interested in the undertaking a brief account of the progress of the institution.

The Indian Forest School at Dehra Dún was established by the Government of India Circular No. 34F., dated 1st July 1878, and the date for its opening was fixed as the 1st June 1879. In the Resolution it was set forth that the School was established to afford to the natives of India scientific teaching in the principles and practice of forestry. It must, however, not be understood from this that no efforts had been made previously to secure a training to the officers of the Forest Department in both the superior and subordinate grades. It is well known that a system of training members for the superior staff was started in 1866, by sending annually a certain number of young Englishmen to the Continent of Europe, to go through a systematic training in forestry in the State and Communal Forests of France and Germany, and to attend the lectures at one of the Forest Schools in those countries.

And again, as early as 1869, attempts were made to commence the training of subordinates in India by the appointment of a small number of native apprentices who were expected to qualify for more extensive and responsible duties than those hitherto entrusted to men of this class.

The idea of an Indian Forest School was, it is believed, formally started in 1874, and in 1876 Sir Richard Temple, then Lieutenant-Governor of Bengal, took up the idea by attempting to establish a provincial Forest School in Bengal.

The difficulties of establishing, at the outset, a provincial school on a satisfactory footing were, however, very great,

and the subject was subsequently dropped for a time in favor of a Central Forest School at Dehra Dún, leaving it for consideration in the future whether provincial schools should not *be set on foot* in addition to the central establishment.

The Circular quoted above said that the School was at the outset intended for the provinces under the Government of India, but that the Governments of Madras and Bombay should eventually be at liberty to send a limited number of students. It was laid down that the School would at first only be used to educate candidates for the appointment of forester or forest *ranger, none but natives of India being admitted, who, if* successful, would leave the School with the so-called 'forest ranger's certificate.'

In order to provide the necessary field for education, it was decided to form the forests of the Dehra Dún and Jaunsar Divisions in the North-West Provinces into a separate Circle, the Officer in charge being the Conservator of this Circle and at the same time Director of the Forest School. As a temporary measure the charge of the Forest Survey was added.

The forests comprised in these two divisions offer a considerable variety of conditions.

There are in the Dehra Dún Division which comprises, besides the Dún, both sides of the Sewalik *range for a con*siderable length, extensive sál forests, sissu forests, mixed forests and tracts covered with bamboos. In the Jaunsar Division we find, at lower elevations, chil forests, while the higher hills are occupied by forests of oak, deodar, spruce, silver fir and blue pine, besides a variety of other interesting trees, such as the box tree, yew, cypress, etc.

So far as regards the field for practical instruction. The officer appointed to be the Director of the new school and Conservator of the School Forests, was Captain Bailey, R.E., until then Superintendent of Forest Survey.

Captain, now Major, Bailey joined the Forest Department in 1871; he was first in charge of the Dehra Dún Division, and then in charge of the Forest Survey Branch. Although not a forester by profession, the choice was doubtless a very happy one, since Major Bailey possesses, in a singular manner, the faculty of guiding and instructing young men, while the more technical part of the forest education is taken charge of by professionally trained forest officers under his direction. The fact that he retains charge of the Forest Survey, offers an excellent *opportunity for training the apprentices in surveying.*

The selection of candidates to be sent to the Forest School was left in the hands of the several Conservators of Forests who were at liberty to send men or not, as they chose, according to the orders which they might receive from time to time from their respective local Governments. The mini-

mum standard of qualifications of apprentices was fixed as follows :—

1*st*.—Ability to read fluently, and write correctly, their own language.

2*nd*.—Arithmetic, including vulgar and decimal fractions.

3*rd*.—A good knowledge of vernacular accounts.

In addition it was said that candidates should possess a good constitution and active habits, and that they should have proved their aptitude for the work of the Department by a practical course of not less than six months duration. A knowledge of English was not insisted upon, but it was presumed that most apprentices would have some knowledge of that language. The limits of age were fixed at from 18 to 25 years.

When the Resolution was issued, it was not considered probable that the students would be willing to pay for their education, and arrangements were, therefore, made for advances to be given to them, and at the same time eight scholarships, at an aggregate outlay of Rs. 120 per mensem, were sanctioned.

The date of admission was fixed at the 1st June in each year, while the course of instruction was to last for two years. The months of June to September in each year were to be devoted to theoretical studies, while the remaining two periods of eight months each were set aside for practical employment in the forests of the School Circle. At the end of the two years' course the successful candidates would receive the 'forest ranger's certificate,' and return to the provinces from which they came, to fill vacancies in the class of forest rangers, or to be employed as foresters, and to be promoted to the class of forest rangers on the occurrence of vacancies, provided they gave satisfaction in the meantime.

The subjects, over which instruction was to extend, were the following :—

(1.) Forestry, theoretical and practical.
(2.) Mathematics.
(3.) Surveying.
(4.) Botany.
(5.) Rocks and soils.
(6.) Meteorology.
(7.) Law.

And it was said that the extension of the course of instruction thus indicated must be effected gradually, or beginning to be made with forestry, surveying and mathematics. The chief aim of the Forest School was said to be *to teach little, but to teach that thoroughly*. It would lead us too far to enter here into the details of what subjects were to be taken up under each head.

With the view of securing efficient professional supervision over the working of the forests attached to the school and the

training of the candidates, a Board of Inspection was formed, consisting of the Inspector-General of Forests or President, and two members, the two first appointed being Dr. Schlich, Conservator of Forests in Bengal, and Mr. Gamble, then Assistant to the Inspector-General of Forests.

So far the original Resolution establishing the school. It will be observed that it provided for a field to work in, for a Director to guide the studies, and for a Board to see that the school forests were properly managed; but it did not make adequate provision for a competent staff of officers to manage the school forests, and to give the theoretical and practical instruction. There were, no doubt, some two or three officers attached to the Dehra Dún and Jaunsar Divisions, but they were fully occupied with the ordinary divisional work, and two additional trained assistants were simultaneously posted to the School Circle, but only one of these joined within a reasonable time. Under these circumstances the only practicable plan was to begin very slowly indeed, by appointing a few apprentices and by employing them on practical work in the forests. It would lead us too much into detail to record here how the staff of the forest school was gradually strengthened, until the Secretary of State accorded his sanction to the appointment of three special officers, namely:—

(1.) A Deputy Director of the School.
(2.) A Deputy Superintendent of Forest Surveys.
(3.) An Instructor, chiefly for Natural Sciences.

In addition to the above, a Working Plan Branch was started, and the officer in charge of it was put under the orders of the Conservator of the School Forests. Gradually the Dehra Dún and Jaunsar Divisions were broken up and formed into four new divisions—the Saharanpur, Dehra Dún, Deoban and Tonse Divisions, held by professionally trained forest officers, who not only look after the practical training of the apprentices in the forests, but who also undertake the theoretical instruction in forestry, while the Deputy Superintendent of Forest Surveys presides over the instruction in surveying. Thus it has been brought about that the Forest School Staff consists now of the following members:—

(1.) Major F. Bailey, R.E., Director of the Forest School, Conservator of the School Forests, and Superintendent of Forest Surveys.
(2.) Mr. W. R. Fisher, B.A., Deputy Director of the Forest School, and in charge of the Dehra Dún Division; educated at the Forest School of Nancy; joined the service in 1872.
(3.) Mr. W. H. Reynolds, Deputy Superintendent, Forest Survey.

(4.) Mr. S. F. Warth, Instructor in Natural Sciences.

(5.) Mr. E. McA. Moir, in charge of the Tonse Division; educated at the Forest School of Nancy; joined the service in 1870.

(6.) Mr. E. E. Fernandez, in charge of the Working Plan Branch; educated at the Forest School of Nancy; joined the service in 1873.

(7.) Mr. A. Smythies, B.A., in charge of the Deoban Division; educated at the Forest School of Nancy; joined the service in 1873.

(8.) Mr. E. F. Litchfield, Survey Branch.

(9.) Mr. A. F. Brown } educated at the Forest School of
(10.) Mr. F. B. Bryant } Nancy; joined the service in 1881.

In addition to the above the services of a mathematical master, educated at the Thomason College at Roorkee, have been secured.

In order to provide a competent teacher of entomology, it has been suggested that one of the students now at Nancy (Mr. Clifford), who has shown a special aptitude for that branch of science, should, at the conclusion of the regular course, devote an additional year to the study of entomology. He is expected to join the Forest School Staff towards the end of 1882.

It will be observed from the above that a strong and fairly complete staff has thus been brought together. Before, however, proceeding to show how it is now being utilized, it will be necessary to go back for a moment, and to explain certain additional measures consistent with the education of natives for the Forest Service. So far mention has been made of forest apprentices, who are to be trained for the ultimate position of Rangers. The Government of India, in their Resolution No. 6F., dated the 3rd February 1879, introduced a new element altogether, namely, the training of so-called Probationers or candidates for appointments on the superior staff of the Department. Originally it was contemplated that only Forest Rangers, who may be considered to be suitable for promotion to the superior branch of the service, may be sent to the Forest School as Probationers, and if they pass the period of probation to the satisfaction of the Director of the Forest School, they may be promoted to the rank of Sub-Assistant Conservator. Subsequently various modifications were introduced, so that at the present moment the following classes of men may be appointed probationers:—

(1.) Forest Rangers and other forest officers in positions corresponding to that of forest ranger.

(2.) Native gentlemen of good position and education who are not in the forest service.

(3.) Gentlemen of European origin, but not more than two per annum.

The minimum of qualification required is given as follows :—

(*a.*)—*Orthography.*

(*b.*)—*English Composition.*

(*c*)—Arithmetic in all its branches.

(*d.*)—Qualification in surveying by the lower forest standard.

(*e.*)—Knowledge of the vernacular according to the lower standard of examination.

Probationers will be deputed to the Forest School for a period of two years, at the end of which they will be eligible to receive either the lower certificate of being competent to hold the position of a forest ranger, being the same as that which may be granted to apprentices, or the higher certificate of being eligible for promotion to the class of Sub-Assistant Conservator.

All probationers will, on return to their provinces, be employed as Forest Rangers. Those who hold the higher certificate will, after having served for two years as rangers, be eligible for promotion to the superior staff.

It will thus be seen that the present intention is to train two classes of men at the Forest School, namely :—

(1.) Apprentices, who desire to qualify for the appointment of Forest Ranger; and

(2.) Probationers, who qualify either for forest ranger or for appointment to the superior staff, as the case may be.

And now we shall return to the School. Soon after its establishment had been sanctioned by Government a suitable house was secured at Dehra Dún. It contains large and airy lecture rooms, besides accommodation for a museum, for the Forest Survey Office and the office of the Director of the School. In a separate building a chemical laboratory has been established.

The buildings stand in a large compound, which is available for nurseries, the planting of trees, &c. Two miles from the school house a forest garden has been laid out, which will be used for experimental plantings and the raising of seedlings on a larger scale than can conveniently be done in the school house compound.

A library, a museum, and an herbarium have been started, and these will no doubt become more complete every year.

As stated above, a commencement was made, soon after the establishment of the School, by teaching the men practically. In the autumn of 1878, the Inspector General of Forests visited the school forests and drew up, in consultation with

the Director of the School, a scheme for managing them, so as to make them as instructive as possible.

In April 1881 the Inspector-General of Forests, and Dr. Schlich, made a joint inspection of the forests. During their visit, they considered, in consultation with the Director, the advisability of commencing a theoretical course of instruction. There were four apprentices and five probationers then under practical instruction, while several additional men were expected to join in June 1881. The unanimous opinion was, that theoretical instruction should now be commenced, and accordingly the above mentioned officers drew up a joint memorandum setting forth the plan to be followed.

The sanction of the Government of India having been obtained, the course of theoretical instruction was commenced early in July, and it is expected to last until the end of October 1881. The details, as they have finally developed, will now be given.

The subjects chosen for instruction during this first course are—

(1.) Mathematics.

(2.) Surveying.

(3.) Botany.

(4.) The elements of Chemistry, Physics, and Mineralogy.

(5.) Forestry.

(6.) Forest Law.

For mathematics a special master has been engaged, who teaches under the guidance of the Deputy Director of the School.

Surveying is attended to by the Deputy Superintendent of Forest Survey.

For Botany special arrangements had to be made, and the services of Mr. Duthie, Director of the Saharanpur Botanical Gardens, have been secured for two months.

The instruction in Natural Sciences is given by Dr. Warth.

The lessons in Forestry have been divided between Messrs. Fisher and Fernandez.

For Forest Law the services of Mr. B. H. Baden-Powell, Bengal Civil Service, have been made available.

It will be observed that, in addition to the regular staff, the services of Mr. Baden-Powell and of Mr. Duthie were necessary at the first course of lectures. In order to use the opportunity to the utmost, it was decided to invite Conservators to send such of their junior officers, as could be spared, for one month so that there are now three classes of students at the school, namely, apprentices, probationers and officers.

To meet the requirements of all, the subjoined plan of lectures is being followed :—

Subjects of Instruction.	Apprentices. Hours.	Probationers. Hours.	Officers. Hours.	Remarks.
Natural Science (theoretical)	A. M. 10 to 11	A. M. 10 to 11	A. M. 10 to 11	
Forestry	11 to 12	11 to 12	11 to 12	Apprentices and Probationers with Mr Fisher Officers with Mr. Fernandez
Natural Science (practical) ..	P. M. 12 to 1-30	P. M. 12 to 1-30	P. M. 4 to 5	
Botany	2 to 3	2 to 30	12 to 1-30 & 2 to 3	
Mathematics and Surveying or Forest Law	3 to 5	3 to 5	3 to 4	

It will be observed that the lectures commence at 10 A.M., and last until 5 P.M., with half an hour's interval. As the number of hours per diem could not be increased, the lectures on Mathematics and Surveying were suspended for three weeks, during which period Mr. Baden-Powell was delivering his lectures on Law.

On every alternate Saturday an examination is being held.

It will now interest our readers to hear something of the attendance, and we therefore give the following table showing what students are attending the lectures :—

Province to which the students belong.	Apprentices.	Probationers.	Officers.	Total.
Bengal	...	2	...	2
Assam	2	...	...	2
N. W. Provinces, Oudh	...	...	1	1
" " School Circle ...	1	2	4	7
Punjab	3	2	2	7
Central Provinces	...	1	1	2
Berar	1	...	1	2
Total ...	7	7	9	23

In addition to the above several of the Professors attend Mr. Baden-Powell's lectures on Law, thus bringing the total audience up to 29.

From the above statement it will be observed that the School Circle and the Punjab compete for the honor of having sent the largest number of men to attend this first course of lectures at the Indian Forest School at Dehra Dun.

Burmah and the N. W. Provinces, *Central Circle*, shine by their absence. As regards the former, distance might be pleaded, but we are not quite sure whether there is not at the same time a desire to argue, that matters in Burmah differ so much from those in India proper as to make it necessary for subordinates to be trained on the spot. If this principle were to hold good, it would have to be applied to the superior staff, and it might be asked what is the use of training our junior officers in Europe before they join in India?

Such a supposition can, however, not be entertained for a moment, because it is too well known by this time that what real progress has been made in forest administration in India during the last 25 years is chiefly due to the judicious application of the experience gained in Europe during more than a century, and in no part of the British Indian dominions is this being felt more strongly than in British Burmah, and we are told that our Burmese friends are about to mend their ways, and to send one apprentice by way of experiment.

But what will the forest world think of the N. W. Provinces, *Central Circle?* We need hardly remind our readers that the men in the Central Circle have only to step across the Ganges, and they will find themselves in the school forests. Hence it must be assumed that in not sending any men for instructions, those directing affairs in the Central Circle are following the fixed plan of not wishing to support the new institution. This, it appears to us, is deeply to be regretted, and the sportsmen-like Foresters of the Patli Dún and adjoining districts should have remembered that *knowledge means power*. The time of filling appointments in India with men untrained for the work is passing away fast, and we feel confident that our friends of the Central Circle have no desire of remaining behind the rest of the world. We trust they will make up for the past, by showing a full muster on the 1st July 1882, when the next course of theoretical instruction commences.

Having thus shortly chronicled the successful launching of our little craft, it may be as well now to show why it must, in the course of time, grow and increase, until it becomes the very foundation upon which the successful administration of our vast Indian forest domains will rest.

The organization of any Forest Department, if it is to fulfil its object, must comprise three distinct classes of officers, namely :—

(1.)—A controlling staff.
(2.)—An executive staff.
(3.)—A protective staff.

It has already been mentioned above that the controlling staff is recruited chiefly by Englishmen trained in the forests and the forest schools of Europe. The protective staff is recruited locally, and in the selection of its members we look chiefly for honesty, a strong constitution, a fair amount of intelligence, and perhaps a knowledge of the vernacular.

There remains then the executive staff. Hitherto this has consisted, first, of officers preparing for the duties of the controlling staff; secondly, of members of the protective staff, who *had specially distinguished themselves; and, lastly—and we regret* to say not least—of men with a fair amount of education picked up as occasion occurred, and very often taken on in a hurry to meet immediate requirements. We need hardly add that a staff thus recruited must contain, besides a number of good officers, a large proportion of men not fit for, and not deserving of, the position given to them.

The management of large forest estates requires special qualifications, because, in the first instance, it must be based upon natural laws, the study of which requires time; secondly, the duty of forest *officers brings them into perpetual contact with* the revenue administration of the country, and with the administration of criminal and civil justice; thirdly, in forest estates a long series of annual incomes has been accumulated, and it requires special skill and knowledge to regulate the use of the stock in hand, so that it may not diminish, but rather improve and enable us to increase the quantity that may annually be removed and made available for the use of the ever-increasing population of the country; fourthly, forests play an important part in the economy of nature, which may become of the highest importance, especially in *mountainous parts of the country, or in* districts subject to the horrors of famine.

It is, therefore, of great importance that the men in immediate charge of our forest estates possess that knowledge and training which enables them to do justice to the work entrusted to them. These men are the members of the *executive branch* of the forest service.

At the present moment the area of reserved forests in the provinces under the Government of India, that is to say, forests which will be permanently maintained as such, amounts to about 16,000 square miles, and it is believed *that this will be brought* up to about 20,000 square miles during the next few years. On an average it may be said that an executive officer can take

charge of about 30 square miles of forest, so that we should require a staff of about 660 such officers, who are generally called forest rangers. Some of the officers trained in Europe will for a while hold charge of ranger, to prepare for higher duties, but in addition we shall have to provide, say, during the next ten years, a staff of at least 600 competent rangers A reference to the list of officers in the Forest Department on the 1st July 1881 will show that we have now only 97 forest rangers, and those who are acquainted with the several provinces know that a number of ranges are now held by foresters, that is to say, by men who should, properly speaking, belong to the protective staff.

It is clear, therefore, that we shall have to educate some 500 forest rangers in addition to those now in the service. And even after the full staff of, say, 600 rangers has been obtained, we shall require at least 20 new men annually to fill vacancies. To train these men will chiefly be the task of the Forest *School. The* commencement *has* been on a small scale, and progress has hitherto been slow to make sure of final success, but now we must go a step further and begin to expand. We have no doubt that conservators are fully impressed with the imperative necessity of providing a competent staff of rangers, and we anticipate that they will compete with each other in obtaining that desirable result in as short a time as possible.

It will now be time to indicate shortly the lines upon which the education of forest rangers is henceforth to be conducted:—

Candidates for appointment as forest rangers, who desire to be received at the Central Forest School, will be selected by conservators of forests under the control of their local Governments.

Students before proceeding to the Forest School should prove their fitness for forest work by service in the subordinate staff of the department for a period of not less than 12 months.

The minimum standard of education required will be that the candidate shall have passed the Entrance Examination of any Indian University on the English side. This rule may, however, be relaxed in the case of men now in the service, and who may be preparing for the School, provided the Director considers that they have reached a standard of education sufficient to enable them to follow the course of instruction with advantage.

At the time of admission to the School students should not be less than 18 or more than 25 years old; they should possess a sound constitution, a good moral character, active habits and all the other qualifications required to make them useful members of the department.

Candidates will join at Dehra Dún on the 1st July. The course of instruction will be partly theoretical and partly practical. The

theoretical course will be held at Dehra Dún, and it will generally extend from the 1st July to the end of October, while the remaining eight months of the year will be devoted to practical training in the forests, either in one of the divisions of the School Circle, or in selected divisions of other circles or provinces. The forest rangers' certificate may be granted at the end of 16 months' course, which will include two terms of theoretical instruction, but it will rest with the Director to extend the course of instructions up to a total of 28 months.

While at the school the Director may dismiss men or remand them to their provinces if considered unfit to profit by the instruction.

On return to the province from which they were sent, the passed men will be appointed as forest rangers, or, in the absence of vacancies, to the higher grades of the class of forester.

As regards the subjects in which theoretical instruction will be given, we invite our readers' attention to what was stated above. Naturally the first course now in progress must show to a large extent what subjects to select in each branch, and how to arrange them. It is, we believe, intended to write, for the present, a short syllabus of each subject, for the guidance of the professors, to be supplemented hereafter by handbooks. On one point, however, all seem agreed, namely that the *quality* of the teaching is to be first considered and the quantity of material put before the students second; in other words, to teach little, but that well, and to connect everything learnt with the practical work of the students. Of this principle we approve most cordially. Here, in India, we have had too much of the system of filling unripe minds with large quantities of material, of which the recipients are afterwards found incapable of making any use, or of applying what they have learnt in practical life. When the primers have appeared, we hope to put some more detailed information on this subject before our readers.

It will be observed that the practical instruction will be given partly in the school forests and partly in selected divisions of other provinces. It would perhaps be better if the students would all remain at the school forests during the whole course, but it should be remembered that a few years hence the average number of students who join the school annually will be at least 20; and as the men of two years may be at the school at the same time, it would not be possible to find profitable work for them all in four divisions; hence it has been decided to send some of the students to selected divisions in other provinces. Of course it need hardly be pointed out here that these selected divisions must be worked and managed on a systematic plan, so that the students may be guided into the right direction. It will

probably be found convenient to keep the students of the more distant provinces, like Burma, Assam and perhaps Bengal, and parts of the Central Provinces, at the School Circle, while those belonging to the North-Western Provinces, Central Circle, Oudh and the Punjab, would return to their own provinces for the term of eight months comprised between the two theoretical terms.

We have in the above described the course of training for forest rangers. It is, however, we understand, the intention of Government to go at once a step further, and to regulate more precisely the manner in which forest rangers may qualify for promotion to the superior staff.

Hitherto the selection of native probationers has not led to very satisfactory results. It has been proposed, therefore, to suspend the appointment of probationers, and to substitute for the present system hereafter the deputation of deserving forest rangers, who have been trained at the Forest School, to that institution for a second or higher course, after they have served for a period of not less than two years since they received the forest ranger's certificate. Rangers thus deputed will, if they pass successfully through the higher course, become eligible for promotion to the superior staff, that is to say, for the rank of Sub-Assistant Conservator in the first instance. Further experience will no doubt develop the principle, and in the meantime it is of importance for the students to know that the road for advancement is open to them, and that it depends on their own exertions whether they will get on in life or not.

In order to make the utmost use of the school, it will probably be arranged that officers of the department, who have not received a professional education, may be deputed to take part in the higher course for rangers, who desire to qualify for the superior staff. This arrangement will doubtlessly be welcomed by all untrained officers, who feel the desire of extending their knowledge, and of putting themselves on a more equal footing with the officers trained in Europe. And thus we shall no doubt gradually advance sufficiently so as to be able to impart a knowledge of forestry not much, if at all, inferior to that now secured by going through the course of studies at Nancy. Of course we must be careful not to fall into a trap at the outset. We mean, that all these things require much time to develop and to form, and we must not expect to reach the top in a day, but advance slowly and steadily, so as to secure final success, and not run any risks of failure or reaction by the way.

Our readers will no doubt agree with us in thinking that the Forest School at Dehra Dún is the very foundation of real and satisfactory progress in forest administration in India. It is also well known that the task of establishing and starting

it was one beset with endless difficulties, and we have to acknowledge the great tact exhibited by Major Bailey, the Director, to whose exertion the success so far obtained is due to a considerable extent. The real author of the School, however, is Mr. D. Brandis, Ph·D., the Inspector-General of Forests with the Government of India. We do not intend to record here in detail the merits of Dr. Brandis as regards the Indian Forest Department; that we hope to do when the befitting moment has arrived, but we cannot conclude this article without a few remarks on the manner in which the establishment of the school has come about.

It is well known that Mr. Brandis joined the service in 1855, and that he served as Conservator of Forests in Burma from 1855 until 1862, when he was appointed Inspector-General—a post he has held ever since, if we leave out of consideration two terms spent on leave. It is equally well known that systematic forestry in India is due to Mr. Brandis' exertions, who brought a vast stock of knowledge and an indefatigable energy to bear upon his work. Almost every great step in advance, with the view of improving forest management in India, was brought about by Mr. Brandis, who may justly be called the father of the Indian Forest Department.

One of the greatest difficulties with which Mr. Brandis had to contend throughout his service, was the formation of a body of reliable and qualified subordinates, fit to discharge the duties of executive forest officers. Consequently many years ago he conceived the idea of establishing a school, in which to train the executive officers. The first real step in this direction was made in 1869, as already indicated above, and ever since the subject has been steadily kept in view, until after endless difficulties he succeeded in establishing the present school. It seems to us that Mr. Brandis' final success may justly be called a triumph, which, without his unswerving energy, would never have been achieved, or at any rate not for years to come.

Although Mr. Brandis' merits are recognised by the present generation, there can be no doubt that his name will become a very household word hereafter, when the effect of his wise measures upon the alleviation of famine will become more evident than it has done as yet. The establishment of the permanent forest estates will secure to the country, not only a permanent supply of timber and firewood, or the proper distribution of the rain-water, but it also makes available enormous quantities of cattle fodder, which in drier parts of India, exposed to the ravages of famines, will hereafter most gratefully be acknowledged by the large number of people who may thus be preserved from the most horrible form of death, starvation, which, without their cattle in the

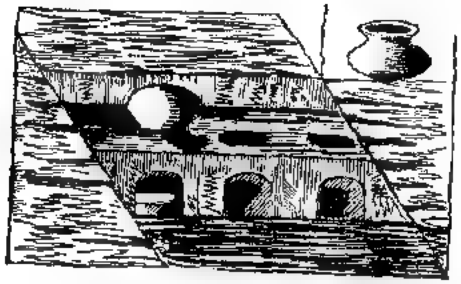
immediate vicinity, would have been their inevitable fate. If Mr. Brandis had done nothing, but pushed on the formation of combined wood and grass preserves in the dry parts of India, he would have deserved well of this country. Let us hope, then, that the principles which have guided him in his work may be more fully appreciated every year, and in this the Forest School of Dehra Dún will and must be the chief pioneer. Sw.

Memorandum on the extraction of Crude Turpentine from the wood of Pinus Khasyana in the Khasi Hills, Assam. By G. Mann.

In the bazars or markets of the Khasia Hills a very resinous wood is sold, which is used by the natives as well as by Europeans for kindling fires, and it is very handy for this purpose.

This wood is produced artificially in *Pinus Khasyana* by cutting a hole into the lower part of the trunk of the tree, about one foot above the ground. This hole is usually 9 to 12 inches wide, 6 to 9 inches high, and 2 to 3 inches deep. After this hole has been cut, the bark and a little of the wood is removed from a strip about 12 inches wide and 4 feet up the trunk just above the hole, which causes the resinous sap to exude, and all the sapwood along the strip where the bark has been taken off to become thoroughly saturated with resin within the next 12 months; and it is even said that the wood of the smaller branches in the crown becomes much more resinous in trees thus cut.

It need be hardly be stated that of course all the exposed surface of the hole and sapwood above it are always more or less covered with solid resin. For the extraction of liquid turpentine oil from such wood as mentioned above, the latter is cut into small pieces or chips, 2 to 5 inches long and ¼ to ½ an inch thick, and placed in layers crossways into an ordinary earthenware cooking pot or vessel, measuring about 12 inches in diameter and 7 inches high, until it is completely filled. After this has been done, the mouth of the vessel is closed by tying large smooth leaves (usually of *Phrynium*) over it. The vessel is then turned upside down, and so placed on a hearth cut out of the hillside as shown in the sketch on the margin. This



hearth consists of a horizontal surface, about 18 inches to 2 feet broad, and a vertical surface of about the same height, and varying in length according to requirements: vertical holes are dug into the horizontal surface 2 or 3 inches less in diameter than the earthen vessels which are to be placed on them, and horizontal holes into the vertical surface to meet the holes made from above. On the holes in the horizontal surface, the vessels with the wood are placed, as already stated, upside down, and the holes in the vertical face of the hearth are cut to place some smaller vessel underneath each one of those containing wood, to receive the turpentine oil as it runs out of the pots above through some holes made for the purpose in the leaves with which the vessels holding the wood were closed A gentle fire is then made on or above the vessels holding the wood, and the hot ashes and burning charcoal kept spread over and around the pots to heat them, the consequence of which is that all the turpentine oil exudes from the wood and drops through the holes made in the leaves into the smaller vessels placed underneath to receive it. The fire up above is kept up as long as there is any oil running out of the vessel.

The pot in which the turpentine oil now described is made contains 6¼ pounds of wood, yielding one pound of turpentine oil. The wood after the turpentine has been extracted weighs 3¾ pounds, so that 1½ pounds weight is lost, which must be the water in the sap that had evaporated in the process, and a little waste of turpentine such as adheres to the leaves with which the vessel is closed.

The resinous wood used for the preparation of turpentine oil sells at present in Shillong at the rate of about 80 pounds for the rupee; but it is also stated that sometimes it fetches half as much again, if there is not a very large amount brought to the bazar for sale.

Development of the trade in Indian-woods in the English Market.

THERE are some parts of India in which the forests contain more timber than there is, for many years to come, any possibility of utilizing with advantage locally. The demand in the Indian presidency towns is still limited to a few kinds of known value; and the foreign market, enterprising as many of the large firms are, still deals very little in any of the Indian woods but teak. In the quotations given in the newspapers we sometimes see mentioned the ebony, satinwood, rosewood and cedar (toon), but the supplies of these which reach the English market are chiefly from other countries than India. The rosewood sold in London or Liverpool is chiefly sent from the West Indies and Brazil, but Indian rosewood or blackwood sells sometimes very well; and

we have been surprised at not hearing of any consignments being sent home for sale after the fine price, £13-10*s.* per ton, obtained in 1878, for specimen pieces sent to London by the Inspector-General. On the Malabar Coast we believe blackwood is plentiful, and even in parts of Northern India it may be met with of good colour and quality. Terai specimens are often met with which have a deep violet colour, and any one who travels in Orissa will be astonished to see everywhere common furniture, such as tables and chairs, made of blackwood of large size and fine markings. A recent writer in the *Timber Trades Journal* speaks of rosewood as being the second wood to mahogany. But it must not be supposed that a price anything like £13-10*s.* a ton can always be obtained—everything depends on the state of the market, and the price often falls as low as £5. Even at this rate if freight is cheap, it may be profitable to ship from forest localities near the sea. On the other hand the price sometimes rises as high as £25, and £15 to £20 per ton are quite common prices for Rio and Bahia wood. Besides selling well in England good markets may be got in France at Havre and Marseilles. Of woods similar to rosewood the most valuable is probably the Burmese "yendike" of which beautiful carvings are often made, and this wood, we are sure, has only to be better known in the European market to fetch a good price. Sissoo, too, should sell well when better known. The price in Calcutta varies from about Re. 1-8 to Rs. 2 per cubic foot, while pieces sold in London in 1878 at £4-10*s.* a ton, and this is probably about the price that may be ordinarily expected, until its good qualities get more recognized.

Cedar wood is of several different descriptions, and is usually quoted as "Honduras," "Mexico," "Cuba," "New South Wales" and "Pencil." The last is the Pencil cedar (*Juniperus virginiana*) similar to which are our chief Juniper woods, *J. excelsa* of the North-West, and *J. recurva* of the North-East Himalaya. The American Pencil cedar is chiefly brought from Florida, and sells in small pieces of 6 to 12 inches square, at from 3*s.* 6*d.* to 4*s.* 6*d.* per cubic foot. This would scarcely be a high enough price to make it pay to send Juniper wood from the Himalayas when the heavy cost of carriage is considered. The West Indian cedar is the wood of *Cedrela odorata*, while that from Australia is *Cedrela australis*, both being nearly related to the toon trees of India which they resemble in wood. This cedar wood sells at about 4*s.* per cubic foot in the British market, and at this rate it might pay to send home surplus stocks from Burma and Chittagong.

Satinwood is of two kinds, coming respectively from the East and West Indies. The former is produced by *Chloroxylon Swietenia*, a common tree of the forests of Central and South India; the latter is said to be the wood of *Maba guianensis*, an ebenaceous tree of the West Indian Islands and Guiana. The

wood is often in great demand and particularly in the French market, and sells at £5 to £10 per ton.

Ebony is usually quoted of five kinds, *viz.*, Mauritius, East Indian, African, Cocus and Green. The East Indian ebony is chiefly sent from Ceylon and South India, the African from the Cape of Good Hope, and Green ebony is the produce of Jamaica, the wood of a leguminous tree (*Brya Ebenus*) which is not black but brownish-green. Cocus ebony is the produce of a West Indian tree which is not well known. Of these, the Mauritius wood is esteemed the best, and is probably the produce of the same tree as the Indian ebony, *viz.*, *Diospyros Ebenum*.

The chief Indian and Ceylon ebonies are *Diospyros melanoxylon*, common in most provinces; *D. Ebenum* of South India; *D. Kurzii*, the Andamanese Marble Wood or "Teakah," and *D. quæsita*, the Calamander wood of Ceylon.

The price of ebony in England is usually about £10 to £20 per ton, equivalent at 50 cubic feet per ton to four to eight shillings a cubic foot. The difficulty about ebony is the small quantity of black heart-wood given by the common *D. melanoxylon*, and it is also probable that the sale of whatever ebony may be available will be better made at the Indian ports than in Europe. But the Andaman marble wood should sell well if sent to Europe, and more especially as it can probably be obtained of larger size than ordinary Indian kinds.

We were under the impression that the Chittagong wood (*Chikrassia*) and Trincomali wood (*Berrya*) were regularly exported, but we do not remember to have ever seen them quoted in the market lists. Ceylon jackwood we have seen quoted at £4 a ton, while cocoanut and palmyra woods fetch about the same or a little more.

Walnutwood is always in good demand, and lately has been sold at 4*s.* 4*d.* a cubic foot in London. Good burrs of course fetch higher prices.

Our remarks on the subject have been chiefly prompted by the receipt of copies of some recent correspondence between the Government of India and the Secretary of State, and between the Inspector-General and Messrs. Gardner and Sons of Liverpool, chiefly regarding boxwood, but also, to some extent, regarding possible substitutes for that wood and ornamental woods generally.

The correspondence with Messrs. Gardner and Sons is very interesting, so we reproduce it :—

Dated the 29th April 1881.

From—Messrs. Joseph Gardner and Sons, Liverpool,
To—The Inspector-General of Forests.

It is some time since we had the pleasure of communicating with you respecting boxwood.

We presume the parcels of wood now arriving from Bombay consigned for sale to Messrs. Churchill and Sim are the product of the Government forests We bought the parcel (about 5 tons) landed Ex *Stratâmore* in London from Messrs. Churchill and Sim at the high price of £30 per ton, and a parcel of 13 tons, Ex *Patna*, now landing in London, is not yet sold, but we suppose £30 is wanted. At these high prices of course the consumption will be very limited indeed.

Can you kindly inform us now what the prospects are of securing any large quantities of this wood, say 5,000 or 10,000 tons, at about £10 per ton in Liverpool or London?

We are drawing our present supplies from Russia and Persia principally; but there are so many fiscal restrictions, and the wood is also inferior to your Indian shipments, that we should prefer drawing all our supplies from India, and possibly our Mr. Thomas Gardner of Poti (Black Sea, Russia) might, when visiting Persia, arrange to pay you a visit also, if you can hold out any inducements to us as regards quantity.

At anything like £30 per ton only very small quantities can be used; at £10, however, it would probably be used very extensively for various purposes for which cheaper woods than boxwood are now used, and in such latter case it would be worth our while to inspect personally some of the Indian forests, and also embark a large amount of capital in this business as well as other Indian woods.

No. 155, *dated the* 6*th July* 1881.

From—The Inspector General of Forests,
To—Messrs. Gardner and Sons, Liverpool.

In reply to your letter of the 29th April 1881, I am very glad to learn that the boxwood sent from India has arrived, and has commanded a good price. As regards the amount of boxwood available in India, in my letters of the 15th June 1877 and the 23rd March 1878, I stated that the boxwood resources of the country are very limited. Since that time some further information has been gained, but there is nothing which modifies in any way the general conclusions stated in my previous letters, to which I beg reference.

2. There is no chance of such large supplies as those mentioned by you (from 5,000 to 10,000 tons) being available from India. Consequently, as regards boxwood, there would be no advantage to be derived from a visit to India by one of the members of your firm

3. As regards other woods, it might ultimately be worth while to depute an agent to Calcutta and Rangoon; but in the first instance it would be well for you to examine the specimens of Indian woods exhibited at the Kew Economic Museum, and the samples which are from time to time sent home for sale to Messrs. Churchill and Sim, London. By writing to the Conservator of Forests, British Burma (Rangoon), and to the Conservator of Bengal (Darjeeling), or to the Conservator of the Central Provinces (Nagpur), or the Punjab (Lahore), these officers will be glad to send you small samples of the woods you might desire.

4. In the meanwhile I have printed this correspondence and sent it to the Conservators named, and also to the Superintendent at Port Blair (Andaman Islands), and asked them to send you samples of hard and close-grained, and light coloured woods likely to serve as substitutes for box, as well as other ornamental woods which they may desire to bring to notice.

It is very satisfactory to find that such a price as £30 per ton was realized by the N. W. P. consignment which consisted of 152 pieces measuring 195 cubic feet. In 1878 only £7 was obtained for some particularly fine specimens, and in 1880, £21 for a previous consignment from the N. W. P. Taking

the ton at the usual rate of 50 cubic foot, £30 per ton would represent at present exchange about Rs. 7 a cubic foot—a very handsome price. It seems to be supposed that good woods likely to become substitutes for boxwood would fetch £10 per ton in England. This is equivalent to about 4*s.* per cubic foot, and this is a price which it may well be worth while to obtain for woods which in the forests in India have little or no market value. Freight for timber may probably be estimated at from £2 to £3 per ton by the Canal, so that even if £7 only is obtained there is at least £4 to recover cost of cutting and carriage to Calcutta and to give a profit. By sailing ship freight would possibly be less, perhaps 15*s.* to £1 per ton only. Of possible substitutes for boxwood, *Gardenia latifolia* has already been recommended in our pages, and we expect that other species of that and neighbouring genus would yield good likely woods. *G. gummifera* we can recommend and also *Plectronia didyma*. The *Randias* would also be worth trying, while the species of *Nauclea*, and possibly *Anogeissus*, might be sent in experiment. Anjan might perhaps be considered too hard. Olive wood, we are sure, would sell well.

Homonoya symphyllicefolia of the Lower Sikhim hills could hardly be distinguished from boxwood if cut square without bark, but the most promising in our opinion is *Murraya exotica*. And besides Murraya there are other Rutaceous trees, like *Limonia acidissima* and *Atalantia*, which have the close hard grained wood so likely to prove suitable. We understand that from several provinces experimental consignments will be sent, and we hope that the sender will oblige us by informing us of the results.

In regard to ornamental woods, we have many in India, though it must be remembered that they will have a hard fight with the beautiful woods of South America and the West Indian Islands.

By far the most promising wood for which a demand is likely to arise is Padouk. The Inspector-General's logs in 1878 fetched £16-10*s.* per ton. This was Andaman wood, and furniture made from Padouk wood by Messrs. Jackson and Graham was very greatly admired at the Paris Exhibition.

In our opinion, the most beautiful Indian wood we have seen is *Gluta travancorica* from the Madras forests, though the Burmese Thitsi comes very near it. *Gluta* wood has a bright scarlet red colour, and is beautifully marked with lines and streaks chiefly of orange and black, and the colour seems to be permanent. Another of our most beautiful woods is the *Pistacia* of the Punjab hills, which is bright yellow with markings of brown and black; while the pinnate leaved Barberry which grows to a considerable size has an orange yellow wood, which, however, is rather apt to darken too much on exposure. The scented woods of the Cinnamomums deserve to be better known, as also do those of the Cordias so beauti-

fully streaked and often scented. But this attempt at enumeration had better stop, or it will be getting tedious, for there are so many more kinds that might be suggested, but we may as well at once suggest the following genera:—Eriolæna, Amoora, Soymida, Mimusops, Pentace, Mesua, Carallia. As already proposed in the case of the substitutes for boxwood, we hope that the INDIAN FORESTER will receive from any of its readers who may send consignments home, a full account of the results with the cost of delivery and freight. We should be very glad to make our columns a more useful record of prices and demand, and hope that our readers will help us. We shall always be glad to receive lists of prices in different localities.

Sub-surface Moisture in connection with the question of the deterioration of Culturable Soil. By Captain Hall, R.E.

PREFATORY NOTE.

THE accompanying note "on sub-surface moisture in connection with the question of deterioration of culturable soil" was, with the exception of some additional remarks with reference to sub-surface drainage, drawn up in April 1879, and forwarded to the Superintending Engineer, 1st Circle, Irrigation Works, North-Western Provinces, for submission to the local Government.

2. A further consideration, however, of the subject has strengthened my conviction that the principles embodied in the note have a much wider import than as regards the mere question of soil deterioration; and I, therefore, gladly avail myself of the opportunity now offered to me for a more general ventilation of these views, by accepting an invitation for the publication of the note in the "INDIAN FORESTER" in connection with certain papers relating to the subject of "reh."

3. The general principles urged in the note are: that in the case of all alluvial deposit within range of aluminous sources, there lies, at varying depths below the surface of the ground, an uppermost substratum, impermeable or nearly so, which, for certain tracts, is practically without "fault;" that this impermeable substratum has its heights and its depressions, its *plateaux* and its valleys, in the same manner as the outer crust of the globe; and, further, that the upper surface of this impermeable substratum forms the "wet perimeter," to use a hydraulic term, of the drainage of each tract, and of which drainage, rivers and minor streams represent the portion only which is visible to the naked eye.

4. Admitting the correctness of this theory of a faultless impermeable substratum, and of the functions that this substratum performs as a means of drainage, it must be at once apparent that the relative positions of this impermeable stratum with reference to the surface of the ground, as well as the configuration of its upper surface, or in other words its topographical features, are most important factors in determining the climatic conditions of a tract of country, and the sanitary conditions of a particular locality.

5. It is beyond the scope of the present paper to discuss the influence on climate of the impermeable substratum, but, as regards the sanitary aspect of the question, I would offer the following suggestions :—

6. In paragraph 6 of the note allusion is made to the frequency of tropical epidemics in cantonments in which the impermeable stratum approaches near to the surface,* and Mián Mír is instanced as a case in point; but, to descend from generalities to particulars, cases may be cited† of the same block of buildings being persistently attacked by epidemics, while the neighbouring blocks escape almost entirely, and consequently the site is condemned as being unhealthy.

7. Were a thorough investigation, by systematic borings, made of the entire locality in which the affected buildings were situated, and an accurate topographical map drawn up showing the horizontal contours of the impermeable substratum, I venture to submit that the following facts would be disclosed :—

1*st*.—That the affected buildings lie immediately over a sub-surface drainage line, the bed of which drainage is the upper surface of the uppermost impermeable substratum; and, further, that at this point the bed of the sub-surface drainage line is depressed below the normal bed of channel, so as to form a basin or reservoir without any outfall!

2*nd*.—That the drainage water, which finds its way into this basin, is drawn from sources, and possibly passes through localities, which in themselves are charged with the germs‡ of disease, and which germs only require exposure to a tropical sun, when brought up to the surface by capillary attraction, in order to develop their vitality.

8. Sketch No. 1 represents a possible arrangement of impermeable substratum contours with six blocks of buildings placed in echelon, diagonally across the sub-surface drainage which dips from north-west to south-east.

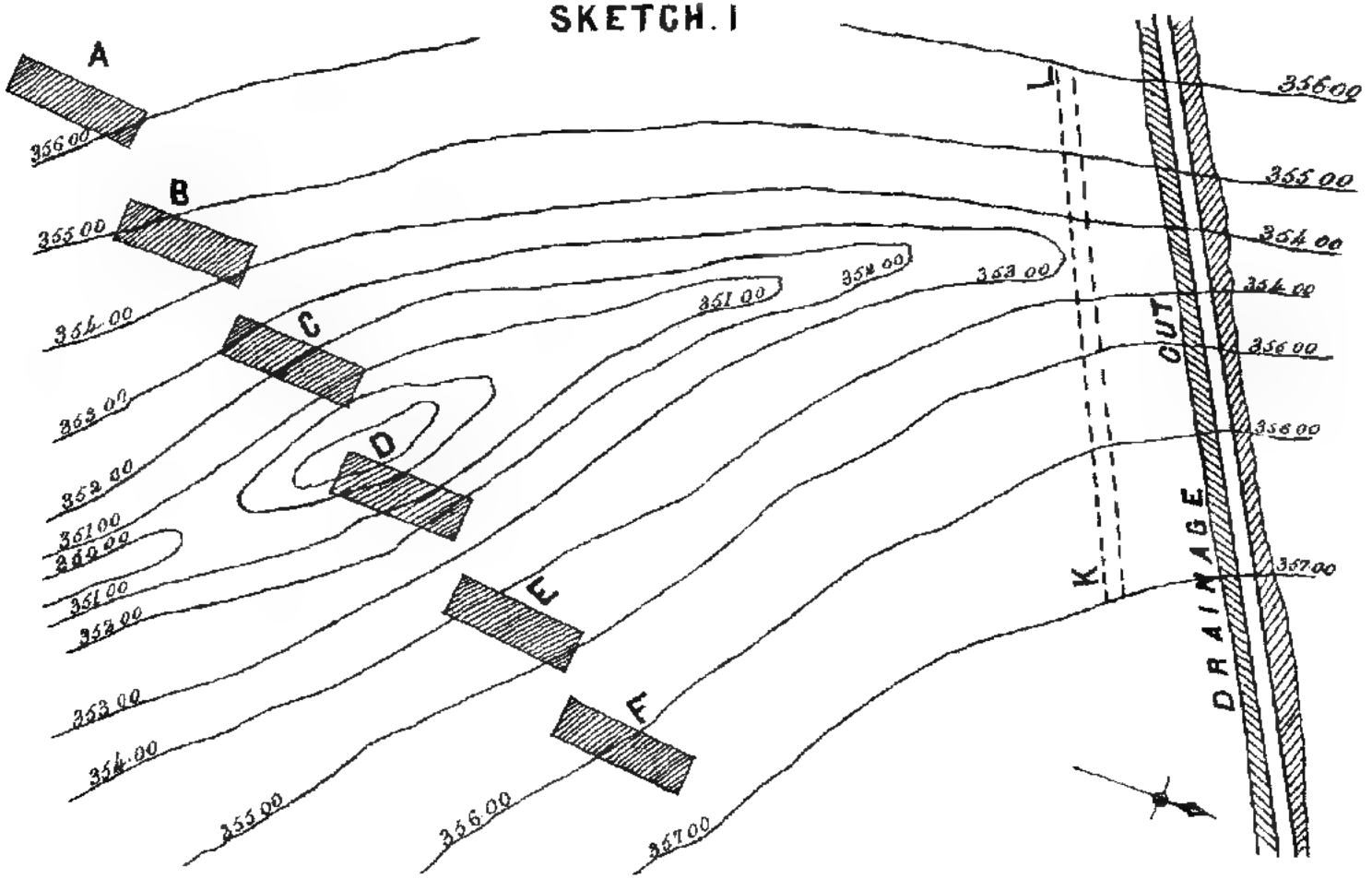
On the north flank of these buildings runs north-east by south-west an artificial drainage cut which carries off the

* *Vide* Table A. and note.

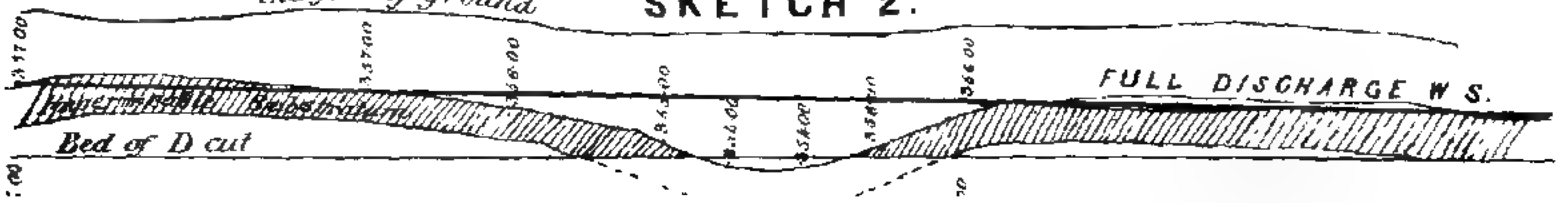
† *Vide* Tables B. and C. and note.

‡ The word *germs* is to be understood in a purely general sense, and not as advocating any particular theory of the cause of disease. Whether ultimately as "spores" or as noxious gases, the action of the sun would have the same effect, in rendering either form inimical to human health.

SKETCH. I



SKETCH 2.



super-surface drainage of a neighbouring town, and where this cut crosses the impermeable substratum drainage line the bed of the former lies above that of the latter, *vide* Sketch No. 2; the result of this arrangement would be that a certain amount of the town drainage would percolate down the impermeable substratum drainage line, and, lodging in the hollow below blocks C and D, would be drawn to the surface by capillary attraction.

9. Should the drainage thus received from the artificial cut bring down with it the germs of disease, the influence of these germs will certainly be felt in the shape of an epidemic outbreak, as soon as they are drawn up to the surface by capillary attraction and exposed to a midsummer sun; and of all these six blocks, C and D are most likely to be affected by the outbreak.

10. Instead of the artificial drainage cut the source of disease might take the form of a cemetery situated upstream with reference to the block of buildings and lying immediately over the sub-surface drainage line.

11. To render therefore blocks C and D free from epidemic outbreaks, it would be necessary, in the case of the artificial drainage cut, to lower its bed, so that the water surface of the flood supply should not at any point "lip" the impermeable substratum belonging to the sub-surface drainage system on which these blocks of buildings are situated. Should, however, it be found impracticable to lower the bed of the drainage, a cut, such as K L, Sketch No. 1, parallel to the drainage cut, and lying between it and the blocks of buildings to be protected, would have to be carried through the impermeable substratum, and provided that the impermeable substratum layer be replaced by sand or other porous material, the cut could be covered in.

12. This latter plan, *viz.*, the covered in cut K L would also have to be adopted in the case of the sub-surface drainage draining a cemetery or any other equally objectionable source of impurity.

13. Under no conditions, however, could the sites of blocks C and D be made absolutely healthy, and were it found imperative to adopt the sites C and D, it would be equally imperative to vertically drain the basin by piercing the impermeable substratum at its lowest points and substituting porous material in its stead.

14. It may be urged that to draw up a map showing the topographical features of the impermeable substratum by systematic borings, would, to be of any practical use, be a tedious and costly process; possibly it might be so at the outset, but in the first place the question is one of protecting human life, and in the second place there is no intelligible reason why, with practice, man should not acquire an eye for the country

underneath the surface as well as for what is visible to the naked eye.

15. The observance of the following principles will, however, aid much the speedy preparation of reliable plans:—

1*st*.—The impermeable substratum lies closest to the surface of the ground on the water-sheds of marked drainages, and falls away as the drainages themselves are approached.

2*nd*.—The nearer to the surface the impermeable substratum the more aluminous and salt-bearing will be the overlying stratum, while the greater the depth below the surface, the more silicious will the overlying stratum be.

16. In conclusion I would remark that, simple as the views may appear which have been urged in these Notes, and though in fragmentary shape portions of the principles insisted on have been admitted, still as a concrete whole I venture to submit that these views have not as yet met with general recognition. The universal adoption of the words "spring level" for the water-surface level of sub-surface drainage; of the word "springs" for an agglomeration of sub-surface drainage; the construction of channels for the passage of water with the water surface "lipping" the uppermost impermeable substratum, and without the adoption of protective measures for those tracts overlying the sub-surface drainage line cut through; the persistent unhealthy condition of buildings in spite of all super-surface sanitary precautions; the construction of buildings in hill stations on the "dip" side of a hill—these and many other instances point most conclusively to a misconception of the true principles on which the major portion of the drainage of the earth is passed on from locality to locality.

In practical life the subject treated of in this *brochure* appeals equally to the agriculturist as to the hygienist, to the engineer as to the meteorologist; and if from them can be obtained a recognition of the principle that under our feet there runs a never-ceasing drainage—a drainage of vastly greater importance than that which is apparent to the eye—I feel certain that a truer appreciation of the causes of and cure for epidemic outbreaks, as well as soil deterioration, will follow as a matter of course.

Note on sub-surface moisture in connection with the question of deterioration of culturable soil.

1. While marching down the last 120 miles of the Cawnpore Branch of the Ganges Canal in March 1879, when the channel was practically empty, and when, therefore, an excellent opportunity offered itself for the study of the substratum for an average depth of six feet, my attention was drawn to the existence of an apparently continuous belt of clay and kankar of varying thickness and at varying depths below the surface of the ground.

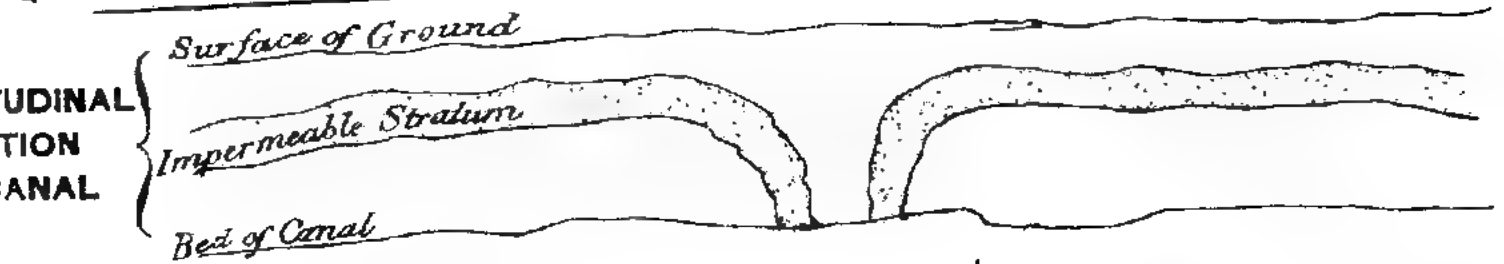
SKETCH N°3.

PLAN

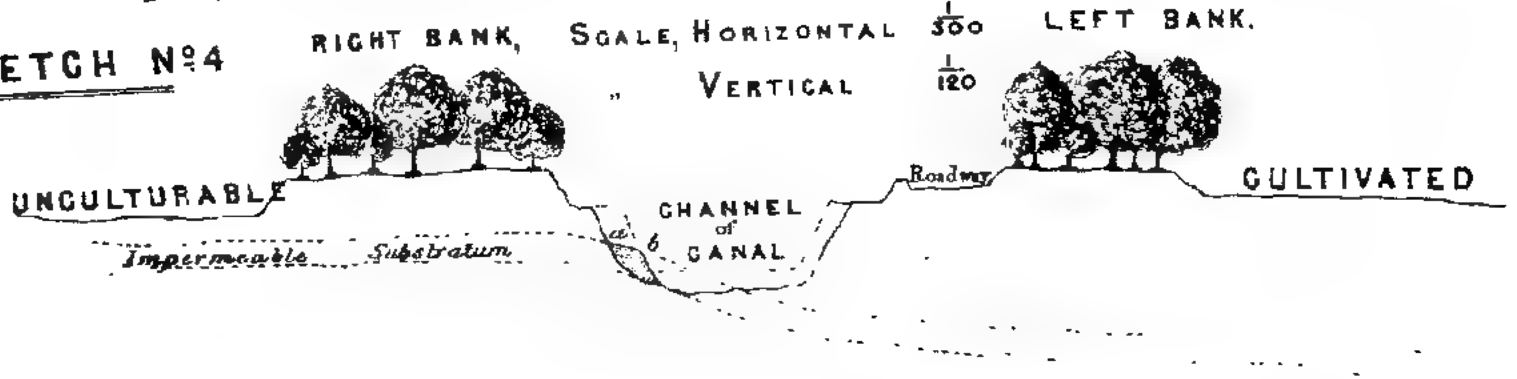
UNCULTURABLE LAND

CANAL

LONGITUDINAL SECTION OF CANAL



SKETCH N°4



2. A closer examination of this clay substratum and comparison with the adjoining surface of the ground disclosed the following facts :—

1*st*.—That where the canal passed through saline and unculturable tracts this impermeable substratum of clay, or of clay and kankar, invariably approached the surface of the ground.

2*nd*.—That where this impermeable substratum receded from the surface the superstratum was culturable.

3*rd*.—That the upper surface of this impermeable substratum as a rule lay below the water-surface level of average supply of canal.

3. Two very striking actual examples of the above noted conditions are represented in Sketches Nos. 3 and 4.

Sketch No. 3 represents in plan the canal traversing an extensive *usar* plain with a narrow strip of culturable land running off from the canal and approximately at right angles to it; in the longitudinal section it will be observed that the impermeable stratum follows very closely the contours of the surface of the ground at a depth of about two feet below it except where opposite to the strip of culturable land, at which point for a width of 30 feet this stratum dips below the bed of the canal.

Sketch No. 4 represents a cross section of canal, channel, roadway, and spoil.

The channel was originally of the dimensions shown in dotted lines, but owing to the action of the current has become enlarged.

The result of this erosion of the channel has been to lay bare the upper surface *a b* of the impermeable substratum, which consists of very stiff clay and kankar, and as the plane *a b* presents so marked a "dip" towards the left bank and therefore rise towards the right, and further, as no trace of this stratum is to be found within the limts of the channel on the left side, a line, prolonged right and left on the slope *a b*, should give fairly approximately the position of the impermeable substratum in the immediate vicinity of the canal.

The sketch further shows that on the left boundary of the canal, in which direction the impermeable stratum "dips," the land is under cultivation, while on the right, in which direction the impermeable stratum rises, the soil is unculturable.

4. Now, perusing the report of the Committee appointed to investigate into the causes of soil deterioration through "reh" efflorescence in Zila Aligarh, North-Western Provinces,

1877-88, I find that this soil deterioration is *attributed* to three causes :—

(*a.*) Rise of spring level due to interception of drainage and excessive irrigation;

(*b.*) The action of canal water, surcharged with saline matter, when laid on culturable soil ;

(*c.*) The action of the wind in bearing saline matter from saline effloresceing plains on to culturable land to leeward.

In connection with these causes I note that no reference whatever is made in the report to the impermeable substratum, nor to the part it plays in soil deterioration ; and, as my own observations have convinced me that no consideration of the subject, whether as regards the disease or the cure, can take any practical shape without the recognition of the fact that the impermeable substratum is the *primary* cause of soil deterioration, and that moisture and saline matter are merely subsidiary adjuncts in the operation, I have therefore been induced to offer the views embodied in this note.

5. This question of the *uppermost* impermeable substratum—for of course it is impossible to say how many of such strata there may be—I look upon as one of the very deepest importance; and it is a matter for regret that no advantage seems to have been taken by the *geologist, of the facilities afforded* for the study of alluvial deposits, during the construction of the several large canals in India and the well-sinking for foundations in the beds of Indian rivers.

6. This question of the uppermost impermeable substratum is also of equally vital importance to the hygienist as to the *geologist*, as the persistency with which tropical epidemics attach themselves year after year to cantonments in which equal attention has been paid to sanitation as in others which escape, points, I think most conclusively, to the existence of some cause for which the locality alone is responsible; and, though I have no statistics to support my theory, still I would with diffidence venture to suggest that on examination it will be found *that tropical epidemics more frequently attack those* localities where this uppermost impermeable substratum approaches near to the surface, than those localities where it is far removed below the surface. Mian Mir is a striking example of the former.

7. An exceedingly favorable opportunity for studying the alluvial section of the Jumna-Gangetic Doab presented itself during the construction of the Lower Ganges Canal, which canal traverses diagonally the entire width of the Doab. For one-half of this width, I append a table showing fairly accurately the relative positions of the uppermost impermeable substratum at various points, with the depth also below the surface.

Table showing position of uppermost impermeable substratum along channel of Lower Ganges Canal from Head to Gopálpur regulated:—

Name of work and position from Head.	Level of upper surface of impermeable stratum	Difference with reference to impermeable stratum in Ganges.		Average depth of bed below surface of ground	Remarks.
		Above	Below		
	ft.	ft.	ft.	ft.	
Ganges River at Head	100	...	...	...	Ganges Channel.
Canal Mile 5—7	152	52	...	25	Head-land.
Canal ,, 14—15	132	32	...	22	Head-land.
Kánkah syphon ,, 20	130	30	...	4	Ganges Khádir.
Sikandarpur ,, 21	130	30	...	4	Ganges Khádir.
Khárla Bridge ,, 23	128	28	...	21	Bángar
Canal ,, 24—26	140	40	...	6	
Barwari Bridge ,, 26½	129	29	...	13	
Jhábar syphon ,, 27½	131	31	...	...	Drainage.
Bilram Road Bridge ,, 32	124	24	...	14	
Cana. ,, 32—33	122	22	...	4	
Khádir of Káli Nadi ,, 33½	112	12	...	2	Káli Nadi Channel and Khádir.
Channel ,, ,, 93½	85	...	15	..	Káli Nadi Channel and Khádir.
Khádir of ,, ,, 83½	112	12	..	2	Káli Nadi Channel and Khádir.
Canal ,, 84	127	27	...	5	
,, ,, 85	138	38	...	6	
,, ,, 86	127	27	...	7	
,, ,, 88—Gopálpur	132	32	...	3 to 4	

The reduced level of the upper surface of this impermeable stratum in centre of channel of the Ganges river at the head of the Lower Ganges canal is taken at=100·00.

An inspection of this table shows that this uppermost impermeable substratum averages 32 feet higher in the centre of the Doab at Gopálpur than it does in the bed of the Ganges at the head of the Canal, which site is about 40 miles higher up the Doab; that this impermeable substratum averages nearly the same height at Gopálpur that it does at mile 23 where the canal leaving the Ganges khádir cuts into the bángar, which site is 20 miles higher up the Doab; and, further, that this impermeable substratum lies 21 feet below the surface of the ground at mile 23, which is on the crest of the bángar and only four feet in the centre of the Doab.

I should also add, as bearing on the subject, what the table does not show, that the stratum overlying this impermeable substratum consists—

(*a.*) In the khádir of the two principal depressions, namely, the Ganges and the Káli Nadi, of a silicious deposit with a small admixture of aluminous matter.

(*b.*) On the high ground, where the impermeable stratum is removed well below the surface, of an almost purely silicious deposit, which deposit becomes more aluminous and salt-bearing as the impermeable substratum approaches the surface.

8. As to the impermeable substratum itself, one very marked characteristic is, that under the channel and khádir of the Ganges and Káli Nadi, as well as under the high ground, the

further removed below the surface, the bluer and richer the clay of which the impermeable substratum is composed; while towards the centre of the Doab, where the impermeable substratum approaches the surface, the layer assumes a brownish hue, which is evidently due to the presence of the salts of lime.

9. The presence of this calcine deposit in the impermeable substratum, as well as the aluminous and saline nature of the superstratum towards the centre of the Doab, can be accounted for only on the supposition that when the Ganges and Jumna were one mighty stream in conjunction with the other Himalayan rivers, the current passing over the present centre of the Doab being, comparatively speaking, as the waters subsided, "on the slack," was only sufficiently buoyant enough to bear along and deposit alumina and the salts of lime, while the heavier silicious matter being borne along by the outer and stronger current, and by it deposited on the margin of the main stream and in intermediate hollows, accounts for the sandy nature of the bângar and of such portions of the high ground where the impermeable substratum is at some appreciable distance below the surface.

It should be borne in mind, however, that the above explanation does not account for the existence of the sandy hillocks which are studded over the *terre-plein* of the Doab, and which are unquestionably the result of sand-drift and are of comparatively recent origin.

Within my own knowledge several wells were laid bare in excavating the channel of the Lower Ganges Canal where it passed through these sand-drifts, the tops of which wells were on an average four feet below the surface.

These wells were constructed of voussoir-shaped bricks laid without mortar, and local tradition placed the period that has elapsed since the entombment of these wells at 200 to 250 years.

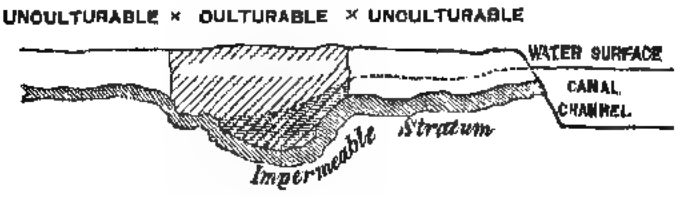
According to the views urged in the previous paragraph, it would appear that these aluminous saline tracts, found in the centre of the Doab, are nothing more than enormous mines of alkalis, and it remains, therefore, to investigate how these mines are, with the assistance of moisture, the cause of the deterioration of the soil.

In the table of approximate upper surface levels of the impermeable substratum, para. 7, it will be observed that the stratum rises and "dips" very considerably throughout the length of 65 miles; and to follow my argument it will be necessary to mentally divest oneself of the comparatively speaking level surface which is apparent to the eye, and to picture to oneself, as lying below the surface, a country in the shape of this impermeable substratum, with its heights and its depressions, its *plateaux* and its valleys.

If, also, at the same time, it be borne in mind that where unculturable soil exists, the impermeable substratum most nearly approaches the surface and "dips" away in the direction of lighter and culturable soil: the observer can, when brought face to face with an unculturable plain studded with bâghs and patches of culturable land, picture to himself the topographical features of the underlying impermeable stratum.

12. Sketch No. 5 represents a cross section of canal, unculturable plain and culturable patch, with the water surface level of canal above that of the upper surface of the uppermost impermeable substratum where cut by the canal, and with the impermeable stratum depressed immediately below the culturable area according to the observations noted in para. 2.

SKETCH NO. 5.



Prior to the "tapping" by the canal of the superstratum overlying the impermeable stratum, whatever rain water was absorbed by the unculturable soil was probably more or less evaporated before any appreciable amount could find its way, laden with saline matter, into the basin underneath the culturable patch; but the superstratum once "tapped," as has been the case by the Ganges Canal, a never ceasing flow of water over this impermeable substratum has been in operation for nearly 30 years; and what matter for surprise is it, if the basin, underlying the culturable patch, has itself become in time an alkali tank, due to sub-surface filtrations of the adjoining unculturable soil situated between the culturable patch and the canal, while the alkaline moisture in this tank, having no means of escape downwards or laterally and following nature's law, is drawn upwards by capillary attraction. Thus are deposited on the surface those alkaline efflorescences which in excess render the soil unculturable.

13. It would appear, therefore, that there are three distinct operations in the deterioration of soil:—

1*st*.—Sub-surface water-flow.

2*nd*.—Obstruction to sub-surface water-flow.

3*rd*.—Capillary attraction.

As regards the two former, the admission of a comparatively speaking water-tight layer beneath the surface, continuous for a given tract, involves of necessity the admission of the capacity of that layer for the conduction of and obstruction to sub-surface water-flow, and of the practical continuity of such a

layer *primâ facie* proof has been adduced; while, as regards capillary attraction in different soils and under varying conditions, it is within the reach of all to test the same for themselves.

The result of a few experiments, made by myself on different kinds of soil with sweet and saline water, may be summed up briefly as follows:—

(*a*). The more silicious the soil the greater the capillary attractive power, which decreases as the soil becomes more aluminous;

(*b*). With like soils the more saline the moisture the more rapid the *updraw*.

I found, that in *pilíyá** earth for instance, the *updraw* is almost twice as rapid as that in *matiyár*, and, also, that in the same earths the rate of *updraw* for sweet and saline moisture is as 1 to 2.

14. In para. 13 I have stated that this second stage in the operation of soil deterioration is *obstruction to sub-surface water-flow;* the word *obstruction* is used advisedly, for though, in the example given in para. 12, the sub-surface drainage is merely arrested by and stored in the hollow underneath the culturable patch, still the result would have been the same had the flow of the drainage been merely obstructed; and I have therefore adopted an expression which will be equally correct under all conditions. Some of the gravest cases of soil deterioration are not to be found on the *terre-plein* of the Doab, but in the khádirs of the subsidiary drainages which are skirted by canal irrigation, or into which has been passed in excessive quantities either canal escape or extraneous drainage water, or possibly both, and to this class of soil deterioration the expression *obstruction* is peculiarly applicable. The impermeable substratum channels, underlying the khádir and channel of these subsidiary drainages, have received for many miles of their length a continuous sub-surface flow of moisture over and above that due to ordinary rainfall, and, in course of time, the discharging capacities of these sub-surface drainage channels being taxed beyond their powers, the sub-surface flow downstream receives a check, and the second stage in the deterioration of the soil of the khadir is accomplished.

This check may be so completed that the moisture may be forced up to the surface without capillary attraction coming into play, and in such cases the soil is said to be "water-logged."

15. In addition to this deterioration of culturable land, there has also been, in the Cawnpore and Fatehgurh districts where traversed by the Ganges Canal—and possibly the same remark

* In the North-West Provinces the classification of soils are:—(1) *Matiyár*, (2) *Dumat*, (3) *Piliyá or Dumat* (second class), (4) *Bhúr*: *Matiyár* having the largest percentage of alumina and *bhúr* that of silex, the remaining two being intermediates.

may apply to other districts—most marked instances of premature decay and drying up of *bágbs*. Whether this destruction of trees be due to soil deterioration, or to the choking of the "tap" roots by the formation of kankar, or to both causes, I am not prepared to say; but, as bearing on this question of kankar growth, I can only state the following facts:—The impermeable substratum *as exposed* in the channel of the Cawnpore Branch of the Ganges Canal, and to which allusion has been made in para. 1, averages two feet in thickness; half at least of this layer is kankar, principally nodular, and on the assumption that this proportion of kankar existed when the channel was excavated, the out-turn, for the 120 miles of canal examined, would have amounted to nearly 300 lakhs of cubic feet.

Of this amount not one-fifth could have possibly been utilized on masonry works belonging to the canal, and the question naturally arises, therefore, as to what can have become of the remaining 240 lakhs, if it ever existed, as no trace is to be found of the same at the present day.

16. The rapid formation of kankar, under the influence of moisture, is a fact on which I have found native experience agreed, while the use of the word "*paida*," with reference to kankar, is common enough in kankar districts.

I myself have been shown a kankar quarry in use in Pergunnah Dádri, Zillah Balandshahr, N. W. P., which was said to have been completely worked out thirteen years previously.

Whether the formation of kankar, under certain conditions, can be as rapid as the instance which I have cited, may be open to doubt; but given a tract, not only surcharged with the salts of lime, but also under the influence of a never-ceasing current of moisture, to deny the possibility of further kankar formation, is to assume a prior finality to nature's operations, for which no parallel exists.

This growth of kankar in the impermeable substratum itself is, however, a factor that can only affect, I should say, arboriculture, as it is not at all probable that the water-tightness of the impermeable substratum can be affected one way or the other by the substitution of kankar for clay.

17. From the preceding remarks as to the cause of soil deterioration the two following facts stand clearly forth:—

(1*st.*) That without sub-surface flow of moisture, soil deterioration is impossible.

(2*nd.*) That where sub-surface flow of moisture exists soil deterioration is only possible, provided—

(*a*) that the sub-surface flow of moisture be "headed up" sufficiently as to cause the "water-logging" of the soil; or

(*b*) that the sub-surface flow of moisture, if charged with saline matter in excess, be arrested in its course within reach of the surface of the ground through the agency of capillary attraction.

The first suggests *preventive*, and the second *remedial* measures, which measures can be best discussed by the examination of typical cases.

18. Sketch No. 6 represents the topographical features, obtained by borings of the upper surface of the uppermost impermeable substratum which underlies an unculturable tract studded with patches of culturable soil: this tract is traversed by a canal, the average water-surface level of which =353·50.

The impermeable substratum contours are shown in black lines: while the area commanded by the water-surface level of canal, is contained between the chain-dotted contours; the culturable patches are shown in black hatching.

It will be observed that the water-surface level contours (353·50), besides commanding the entire impermeable substratum underlying the culturable patches, Plots 1, 2, 3, also commands a certain area of unculturable soil, which, be it assumed, contains alkaline salts. The effect of this continuous stream of moisture will be to drain the alkaline salts into the lowest points of the basins underneath these plots—a result which will be much facilitated if the level of water-surface be subject to fluctuations, and according to the process detailed in para. 12, these plots in course of time will be rendered unculturable, provided that the alkaline salts are delivered in excess.

This deterioration is brought about, as has been pointed out, by the obstruction downward or laterally to the free flow of the saline sub-surface moisture when delivered in excessive quantities. And the remedy that most naturally suggests itself, in order to overcome this obstruction, is to pierce the impermeable substratum in these hollows, and thus allow the sub-surface drainage to pass through into the underlying stratum.*

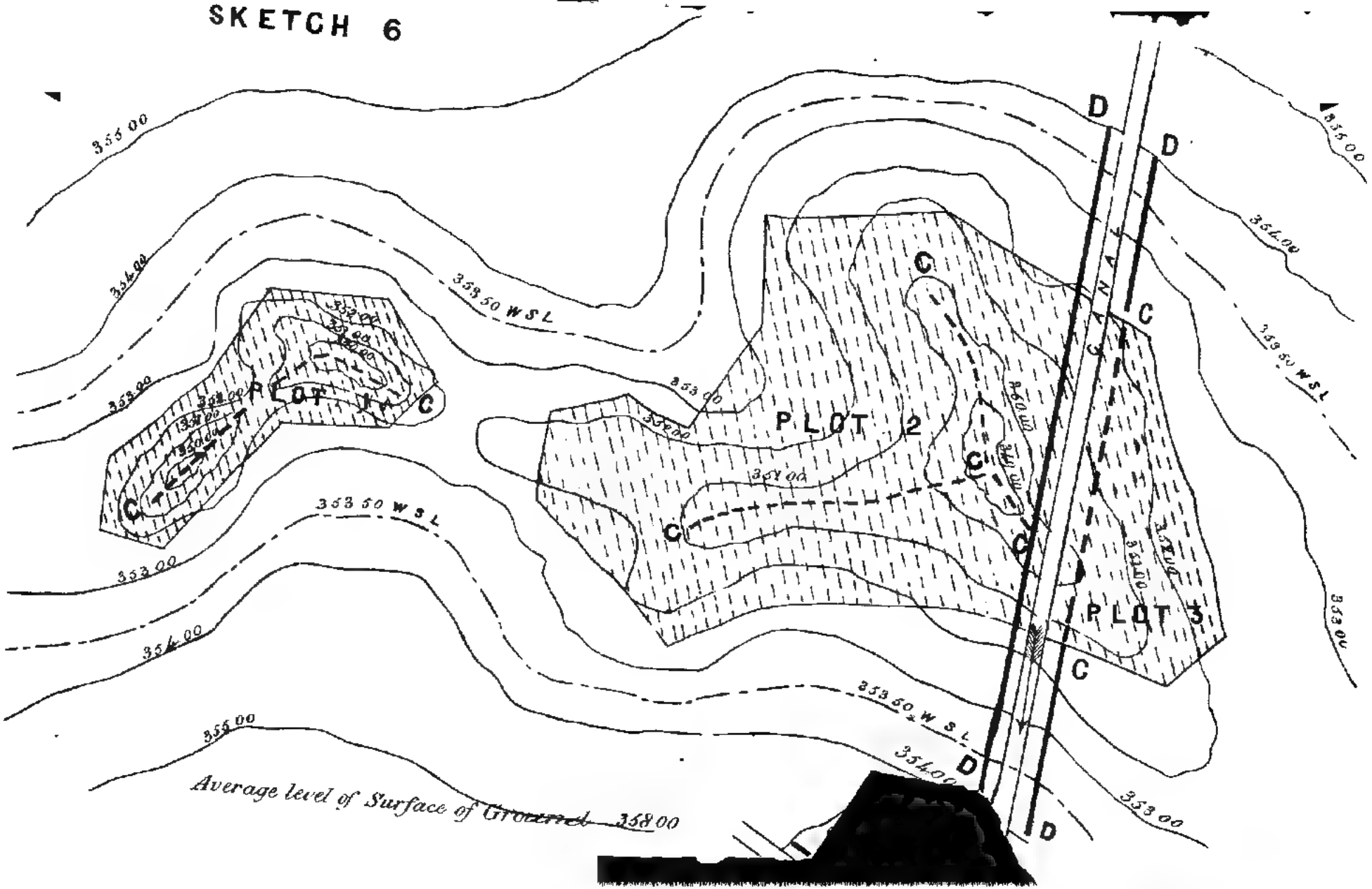
This piercing of the impermeable substratum might take the form of wells at convenient distances, or of cuts, as per broken block lines C C, and if, for the impermeable substratum, some porous material, such as sand, ballast, &c., be substituted, these wells or cuts could be covered in and brought under cultivation.

Measures, such as those proposed, would be purely *remedial* ones, and it would be a question for consideration in each individual case, whether *preventive* measures would not be more advisable on the score of expense as well as of expediency.

By *preventive* measures is to be understood the stoppage at the outset of the sub-surface flow, or in other words the cutting

* Since advocating this plan of drainage through the impermeable substratum, I notice that in the INDIAN FORESTER for July 1879, pages 116-117, is quoted a letter from the "Journal of Forestry," which describes the draining of a marsh in Wales through the aid of the Italian poplar, the roots of which, piercing right through the bed of clay into the underlying stratum, provided vertical outlets for the moisture.

SKETCH 6

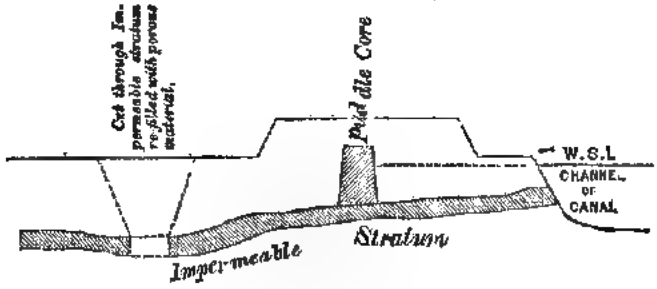

355 00
354 00
353 00
353 50 W S L
PLOT 1
PLOT 2
PLOT 3
C
D
Average level of Surface of Ground 358 00

off the communications; this stoppage of the sub-surface flow could be effected in two ways:—

(1*st*) By intercepting the percolation of moisture from the canal, within the limits in which the water surface "lips" the impermeable substratum, by means of a puddle core in the bank of the canal.

(2*nd.*) To pierce the impermeable substratum on both sides of canal and in close proximity to it, by cuts extending the distance in which the water surface "lips" the impermeable substratum, these cuts being dealt with as proposed in adopting *remedial* measures. Such cuts are represented by block lines D D in sketch No. 6. Sketch No. 7 represents in cross section canal and adjoining ground, in which the treatment adopted is a combination of Nos. 1 and 2.

SKETCH NO. 7.



The clay, excavated from the impermeable substratum, can be utilized in forming a puddle core in the canal bank, and the core being carried up to, say, two feet above water-surface level, the advantages of both methods are secured.

20. Generally speaking it would be found preferable to adopt purely *remedial* measures in the first instance, were the deterioration of the soil in a very advanced state, as with the impermeable substratum pierced in the hollows by cuts as C C — Sketch No. 6—a free flow of sub-surface moisture would act as a powerful agent for good, by washing the alkaline salts out of the soil through the cuts into the underlying stratum; at the same time it might be found necessary to cut off the communications with the salt-bearing portions, were the area of the latter commanded by the water-surface level to any great extent. It must be self-evident, however, that it is impossible to lay down any hard and fast rules on the subject of cure and prevention of soil deterioration, and that each individual case must be treated on its own merits, provided that the obligatory principle be observed, *viz.*, giving the sub-surface drainage free access to the stratum underlying the uppermost impermeable substratum. As soon however as the soil affected has been reclaimed, then *preventive* measures, in order to guard against a recurrence of the

evil, would be obligatory; while, in the case of new canals, where it is found impracticable to lower the water-surface level below the impermeable substratum, *preventive* measures would likewise have to be adopted.

21. In the case of soil deterioration in the khádirs of subsidiary drainages, which deterioration is due to the "heading up" of the sub-surface drainage, I should recommend *remedial* measures in the first instance, the drainage itself being eventually treated in the manner proposed in para. 29.

In the neighbourhood of the channel of the drainage itself it will be found that the impermeable substratum lies near to the surface, and that it suddenly "dips" below the channel—*vide* khádir and channel of Ganges and Káli Nadi Table, para. 7, and I should, therefore, propose to cut the impermeable stratum *across* the khádir, where the former is within reasonable distance of the surface, and at such distances as may be considered suitable, leaving the substratum under the channel untouched should its depth below the bed render the plan impracticable.

Hitherto in cases of "water-logged" khádirs of drainages, it has been the custom to widen and straighten the channel, but the relief afforded thereby can at the best be only partial, and sooner or later the evil in as aggravated a form as before will make itself felt.*

22. The *remedial* measures proposed by the Committee referred to in para. 4 are stated to be of a purely tentative nature, and comprise—

(*a*). Deep drainage.	(*d*). Manuring.
(*b*). Sub-soil drainage.	(*e*). Arboriculture.
(*c*). Flushing.	(*f*). Growth of special crops.

Beyond these proposed tentative measures, it was further recommended that irrigation should be reduced in certain affected districts. Of these remedial measures—

(*a*). Deep drainage
(*b*). Subsoil drainage

deserve special consideration.

The only form of drainage advocated in this Note is *vertical* drainage, compared with which the two forms of drainage proposed by the Committee would be *surface* drainage, and their nomenclature would become—

(*a*). Open *surface* drainage.
(*b*). Enclosed *surface* drainage.

23. Now, as regards *open surface drainage*, whether deep or shallow, it must be evident from the conclusions already arrived at, that should the water-surface level in the drainage cut at any point "lip" the impermeable substratum, the presumably

* As to the inefficiency of deep drainage, as a means of lowering the sub-surface moisture, reference is invited to a memo. attached to this Note by Mr. J. S. Beresford, Executive Engineer, I. D., N. W. P.

saline bearing drainage water would percolate down the impermeable substratum depression at that point, and lodging in any hollows or *cul-de-sac* in this depression, would, in course of time, cause the very same deterioration of soil, which is being brought about by canals where their water surface level "lips" the impermeable substratum; and thus a work originally intended to benefit the country drained by it might prove a positive source of harm.

24. Of course with an accurate survey of the topographical features of the uppermost impermeable substratum, a drainage cut might be constructed, so that its water-surface level should not "lip" the impermeable substratum where the saline moisture can do injury; but why, I ask, go to this expense? Why, I ask, open out drainage cuts and thereby throw out of cultivation culturable land, which is equivalent to a loss of six per cent. on invested capital? Why, I ask, go to the expense of *subsoil*, or more strictly speaking *enclosed surface drainage*, when we already possess a most efficient system of drainage lines in the valleys and depressions of this uppermost impermeable substratum, provided that free access for the sub-surface drainage to the underlying stratum be given by *vertical* drainage where found necessary?

I might further ask, what can be said in justification of any system, which, whether by drainage or "flushing," has for its object the removal of a hurtful excess of saline matter from one to act to another lower down; and has for its result not the removal of the evil itself, but of its *locale?*

25. True it is that this *surface* drainage is merely an imitation of what we find in nature, but equally true it is that in nature we find tracts deprived, by means of this *surface* drainage, of moisture which they can ill afford to spare—tracts in which the annual rainfall averages only 30 inches while the evaporation averages 50 inches and over.

Is it not equally true that, due to this *surface* drainage, while one tract has not sufficient moisture to meet the requirements of evaporation, other tracts are "water-logged" to such an extent as to be unfit for human life for a portion of the year? And, further, is it not a fact, that as "like begets like," so in nature *surface drainage* begets *surface* drainage, and that, due to this action, a sure but gradual wearing away of the upper and culturable crust of alluvial tracts is taking place, to an extent, which is measurable neither by one generation or by ten, but by the fact that such erosion has taken place, is taking place, and will continue to do so until arrested by the hand of man.

26. Such a formidable indictment as the preceding one against *surface* drainage would, in its application to the question of artificial *surface* drainage, be grave enough did not some way out of the difficulty offer itself; and though some

of the views which I am about to offer are neither new nor original, still I trust that their further advocacy in this Note may awaken an interest in a question of such deep importance. As the combined waters of the Indo-Gangetic valley subsided, and the currents of the Ganges and Jumna gradually separated, an insular deposit, of triangular shape, stretching from the present sites of Saharanpur and Rurki on the north to Allahabad at the southern apex, commenced to be formed, and like all such subcurrent deposits, the underlying strata of the Doab assumed in shape externally that of a series of furrows running in the direction of the current.

As time wore on, this furrowed deposit came to be *coated* with the aluminous and calcine bearing deposit which in this Note has been known as the *uppermost impermeable substratum*, while a sudden rise and equally sudden fall of waters brought down and deposited, in the hollows of this impermeable substratum, the upper crust of the Doab, which, as we have already seen, is silicious in proportion to the depth of the hollow; so that, when the subsiding waters left the *terra-plein* of the Doab high and dry, the contour of its cross section was comparatively level.

As the waters still further subsided, and the downstream ends of those furrows came to be exposed above the water surface level, the moisture contained in them being afforded a means of exit, the gradual exudation of the sub-surface moisture brought away with it some of the silicious deposit contained in the furrows, and thus a start was given to the series of subsidiary drainage lines, which at present cover the face of the Doab. Sub-surface drainage and rainfall between them have so far completed what moisture exudation in the first instance commenced, and thus the subsidiary drainages of the Jumna-Gangetic Doab of the present day are nothing more than those clay-lined furrows partially deprived of their original "padding."

27. The result of this gradual hollowing out of the "filling in" of these furrows has been to alter the entire aspect of the country—has been to render certain tracts incapable of retaining their own rainfall, while others receive over and above their own share; in short the effect has been to unbalance the climatic conditions of the Doab, and as in the human frame an unequal circulation is coincident with disease, so an unequal distribution of moisture is coincident with unequal rainfall and its attendant epidemic outbreaks. Further, an unequal distribution of sub-surface moisture makes any scheme of irrigation, without producing hurtful results, practically impossible.

28. To propose that human agency should restore the *terre-plein* of the Doab to its original form, would be Utopian in its absurdity; but it is nevertheless within the power of man to

restore in a very great measure the balance of moisture distribution, by working on certain lines which are the antithesis of *surface* drainage.

29. Unequal distribution of moisture is brought about by the tracts forming the catchment basins of drainages being unable, from their slope of surface and want of obstructions, to retain all the moisture which they receive in the shape of rain, while, as has been explained, time was when their catchment basins did not exist, and when their present sites were one comparative level.

Now, were this retrogression of the surface of catchment basins kept within controllable limits by systematic obstructions along the contour levels of the ground to the flow-off of rain water, in course of time and with care these inclined surfaces of catchment basins would be transformed into a series of level *plateaux*.

Likewise the drainage lines and hollows could be treated much in the same way; deprived of their customary supply of drainage water from their catchment basins, it would be an easy matter, in the case of drainage lines, to place like obstructions to the flow-off of drainage *across* their khádirs and channels; at the same time were there any tendency to "water-logging," the difficulty would be overcome by *vertical* drainage through the impermeable substratum as proposed in para. 21, while the process of forming these *plateaux* would be facilitated by the cultivation of low scrub, which would aid the deposit of "drift."

Isolated hollows might be drained by the growth of the Italian poplar, *vide* foot note, para. 18.

30. As regards the remaining three tentative *remedial* measures proposed by the Aligarh Committee, *viz.*—

(*d.*) Manuring,
(*e.*) Arboriculture,
(*f.*) Growth of special crops,

I have only to remark that there is the most marked distinction between soil that was at one time culturable and which is now thrown out of cultivation owing to the rise to the surface of alkalis, and soil that has never been *culturable; the* case of the former indicates that an active agency for evil is at work, the source of which evil lies outside of the land affected; and, until the *source* of that evil be mastered by the *remedial* and *preventive* measures already proposed in this Note, the success of either of these three remedies recommended by the Committee must be very doubtful; while, on the other hand, the land, that for some reason or other has never been culturable, contains in itself the *entire* source of its hitherto sterility, which sterility may be due either to a hurtful excess of alkalis, or to non-porosity of the soil, or to both causes, which causes can, however, be ascertained to a certainty by examination and analysis, and the land can therefore be

dealt with accordingly as recommended by the Aligarh Committee, provided that the scheme be financially sound.

In short these two cases are as widely apart as they can possibly be—the one possessing *active* potentiality for harm which is indefinite, while the potentiality for harm of the other is *passive* and well defined.

31. The proposal of the Committee to induce the supply of canal water in districts affected by the spread of "reh" efflorescence, must commend itself to every canal officer who has had experience of the wasteful expenditure of canal water by the cultivator, as compared with his frugal and careful management of his well water.

And though, doubtless, improvement as regards the economical use of canal water has taken place of late years in the North-West Provinces, still, under existing conditions of water distribution, a thoroughly economical expenditure of canal water is impossible.

32. *At present the irrigator pays for the land he irrigates, and not for the land, which the water he has consumed ought to irrigate, according to his own standard for well irrigation*; so that the inducement to make the most of canal water is practically nil, and the results are, wastage from the irrigating channel, excessive watering both as regards quantity and frequency, quantity and quality of grain sacrificed for stalk.

If actual facts supplied the argument that the canal irrigator is the best judge of his own interests, then there would be nothing more to say on the subject; but my own experience is, that canal irrigation has brought into existence a class of cultivators who sacrifice real for apparent outturn, especially in the case of rabi cereals, and that in canal irrigated districts the *practical* cultivator is the man who has to depend on his well for irrigation.

I have myself checked rabi fields while being canal irrigated *by lip*, and found that, notwithstanding the extra labor and expense involved in raising the water, over seven inches of water was being laid on the field, instead of the 4½ to 5 inches, which would at the very outside be given in the case of well water.

I also find, from the statistics of the Cawnpore division of the Ganges Canal, that the average depth of water laid on the soil, *at each watering*, for the six years ending 1879-80, is at the very lowest computation—

Rabi =7·6 inches;
Kharif =8·3 inches;
Mean =8·0 inches;

and I believe that these figures will compare favourably with those of the upper divisions of the canal.

Now, if to the five-inch standard we allow 20 per cent., a most liberal allowance, over and above, for loss by absorption and evaporation, the total expenditure on each watering should

be six inches, leaving two inches to spare according to the mean expenditure of the Cawnpore division, which two inches, at the six-inch standard, would give an extra return of 33 per cent. over the present irrigation—a return equivalent to 50,000 acres or one lakh rupees of water revenue annually.

33. The existing conditions of sale of water for irrigation is the outcome principally of a lengthened period of prejudice and disinclination on the part of the cultivators to use canal water; in fact there was a time when canal water used to "*go-a-begging*," but now a re-action has set in, and at present the demand for water is much in excess of the supply. Under entirely altered conditions, therefore, in which all the water in the Ganges Canal is, as far as practicable, expended on irrigation and more could be utilized; in which also regularity of supply at the heads of distributaries has been secured, the objections to a *water settlement*, based on the supply given at the *outlet head*, which have hitherto held good, have now ceased to exist.

True, many objections might be urged against the proposal, but in the face of the evils present and prospective, due to excessive watering, a *water settlement* which will secure economical consumption is worth a trial on a small scale to commence with; the scheme, placed in the hands of a specially qualified officer unfettered by other work, would, I feel confident, be launched and worked without much difficulty; while the present regularity of demand for water is the surest guarantee that calculations would not be falsified, and dispenses with the necessity for water-modules or any complicated machinery for regulating the supply of each outlet.

34. The cultivators themselves, too, would hail with delight any scheme which will ensure them a fixity of supply, and which will deliver them in a very great measure from the clutches of the native establishment—a scheme which will place the strong and the weak on the same footing, and which will tend more than anything else to diminish canal criminal cases; wastage of water as a loss of revenue to Government will cease to exist, and, in short, the irrigating community would, in canal matters, become its own police.

35. As a tentative measure, a settlement of one distributary system might be taken in hand subject to revision after, say, 6 *fasls* or any other multiple of three, to allow of crop rotation, the area irrigated being, for purposes of check, measured up *fasl* by *fasl* as at present, the water rent payable being of course the amount settled for the water supplied based upon what that supply of water could irrigate with a given standard, having due regard to the command, class of crop likely to be cultivated, conditions of tenure of field, and existing irrigating interests.

36. It may possibly be urged that this scheme of a *water-settlement* cuts at the very root of the principle on which irri-

gation works are constructed, which principle is that these works are primarily intended as preventives against famine; and that therefore any settlement is to be deprecated, which would tie the hands of the Canal Department in years of heavy demand, and thus prevent its officers from supplying water to *outsiders* without curtailing the privileges of regular consumers.

An argument of this nature would have had force and been admissible some years ago when canal water was not appreciated to the extent it is now; but when applied to the altered conditions of the present day, its basis as to the existence of *outsiders* becomes fallacious; for, should this scheme of a *water settlement*, as I maintain it will, eventually provide not only for the same irrigation as at present, but, in the case of the Ganges Canal, liberate at least 25 per cent of the present supply for the equalization and provision of irrigation in villages and tracts, which at present do not receive their fair share of water, seasons of exceptionally heavy demand as well as normal seasons will find canal water not only utilized to its fullest extent, but its beneficial effect equally distributed; in short both seasons will alike disclose a matured system of equable distribution and economical expenditure, instead of, in years of scarcity, a haphazard and spasmodic attempt at equable distribution without the slightest guarantee that the water would be economically utilized.

APPENDIX.

TABLE A.

Statement showing the number of Cholera cases in each branch of the Service at Meerut.

Year.	British Cavalry.			Artillery			British Infantry.			Native Troops.		
	Strength.	Cases.	Ratio per Mille.	Strength.	Cases.	Ratio per Mille.	Strength.	Cases.	Ratio per Mille.	Strength.	Cases.	Ratio per Mille.
1861 ...	747	46	...	1,162	93	...	1,315	42	...	451	4	...
1862 ...	615	Nil	...	637	22	...	826	34	...	759	Nil.	...
1867 ...	380	4	...	574	1	...	705	107	...	717	Nil.	...
1869 ...	440	1	...	522	Nil.	...	546	5	...	842	Nil.	...
1872 ...	424	4	...	561	31	...	460	33	...	890	2	...
1875 ...	628	1	...	802	10	...	688	1	...	882	2	...
Total ...	3,234	56	17	4,259	157	37	4,540	222	49	4,541	8	2

The following extract is taken from the Report on Cholera Epidemics, Meerut, published by the Q. M. G.'s Department, 1877, page 48, with reference to the epidemic of 1861 :—

"The drainage of cantonments was far from satisfactory at this time. The main line of drainage divided the sandy surface of the Native lines from the clayey soil of the European lines; and on the side of the Native lines, although occupied by bazars and officers' bungalows, very few cases of cholera occurred.

"Dr. Wilkie, Inspector-General of Hospitals, considers this part of the station to be less liable to the disease than the European lines, owing to the protection it derives from the layer of sandy soil which overlies the clay. It has been observed at present, both in previous epidemics as well as in those noticed hereafter, that those parts where the dry sandy soil is wanting and the surface composed of a bare sterile clay have suffered most severely."

Now Table A shows that the average severity of cholera epidemics for six years is in the following order :—

British Infantry	cases	49	per	mille.
Artillery	do.	37	,,	,,
British Cavalry	do.	17	,,	,,
Native Troops	do.	2	,,	,,

And, as far as my memory serves me regarding the nature of soil on which these different branches of the service are located, the ratio of cases is inversely proportional to the sandy nature of the superstratum; and it has already been pointed out in the Note that the more silicious the superstratum the lower removed the impermeable substratum.

Table B.

Statement showing number of Cholera cases from each Branch, at Morar.

Year.	Single-storied Barrack.											Double-storied Barrack.								Staff quarters No 58 & stray	Family quar No 12 D. B.
	5	6	7	8	9	10	11	12	13	15	18	1	2	3	4	5	6	7	8		
1875 ...	1	1	..	2	1	1	1	1	1	..	2	...		1	.	.	.	.	1	1	
1877 ..	2	..	..	.	..	1	...	...	...	...	.	unaffected									
1878 ..	8	3	1	1	..	1	...	...	..	...		14 in 1 2-4						7	3	...	..
1879 ..	5	...	...	1	1	6	2	...	1	1		1	...	..	.	.	.	.	.	...	1
Total..	16	4	1	4	2	8	3	1	2	1	2	...	...	..	.	.	7	2	1	2	

Table C.

Statement showing number of Cholera cases in each Barrack, Infantry Lines, Cawnpore.

Year.	European Double-storey Barrack.									
	1	2	3	4	5	6	7	8	9	10
1869 ...	...	...	...	...	...	1	affected	4	1	
1870 {	...	...	(not affected)							affected
	...	...	15 cases in 1, 2, 5, 6, 7, 8, 9, 10							
1872 ..	...	...	...	...	...	...	...	1	3	
1875 ...	...	...	4 cases Barracks not stated.							
1876 ...	...	..	3	do.			do.			
1878 ...	...	...	..	...	...	1	...	...		
1880 ...	..	...	...	...	...	...	4	7		

These data furnished in Tables B and C are extracted from the Report on Cholera Epidemics published by the Q. M. G.'s Department; these data show that the following groups of buildings have a tendency to be affected during cholera epidemics:—

Morar Single-storied Barracks Nos. 5, 6, 8, 10.
Cawnpore British Infantry Barracks Nos. 7, 8, 9.

For the other cantonments in the Bengal Presidency this information in detail is not traceable in these reports, but as the only data which is obtainable show that certain blocks of buildings have a tendency to be affected during cholera epidemics, it is more than probable that were like details for the coming for other cantonments the same marked tendency would be recognizable.

Appendix to Note by Col. H. A. Brownlow, R.E., *on causes of deterioration of land by reh.*

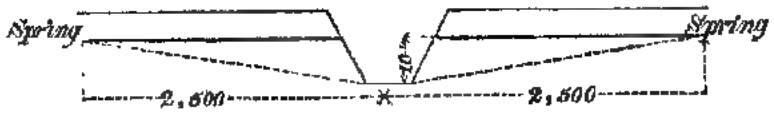
As bearing on the conclusions come to by the Reh Committee and others regarding the efficiency of deep drainage, I append three tracings* showing to what a limited extent deep drains seem to affect the spring-level.

Captain Ross, in his observations along the edge of the Káli Nadi bángar, found that the spring-level sloped towards the

* Not printed.

khádir at an inclination of 1 in 250. This agrees with my observations at the tail of the Siana escape in the Ganges bángar, Meerut district, where the difference of spring-levels at two falls, only 2,000 feet apart, was 8 feet.

According to these data, a drain, of which the bed is 10 feet below the spring line at site of drain, would, in the ordinary course, only affect the level of subsoil water for a distance of 2,500 feet on each side, and such a drain would have to be deepened gradually.



But ordinarily what are called deep drains in this country are not more than a few feet below spring-level.

The cross section of the Deoband Doab shows that the spring line is not affected for more than a width of two miles on each side of the Hindun and West Káli nadis, although the cold weather levels of the nadis are from 15 to 20 feet below the spring-level in the Doab. The line of spring-level alongside the Bhognipur Branch, Lower Ganges Canal, is very remarkable. There is a fall of 20 feet between miles 13 and 12.

The plan of ground between East Káli nadi escape and Lower Ganges Canal embankment at Nandrai, in which the R. L.'s of spring water are entered at very close intervals, shows a distinct and rapid rise as we leave the escape, which in this case is acting as a deep drain, for the water can be seen oozing out of the banks on each side.

The line of levels on the right side of the embankment shows that the canal-water, several feet higher than the spring-level, has had no effect whatever on the latter.

Judging from para. 19 of Mr. Michel's letter, page vii of Reh Committee's report, it is assumed that we have only to dig a canal or drain to R. L. *x*, and the spring-level for an indefinite distance all round will at once or in time sink to *x* also; and a perusal of the report leaves an impression that the majority of the members had the same views as Mr. Michel as to deep drainage. But I think the facts quoted above, and clearly shown on the tracings appended to this, go to prove that even the average rainfall (without the additional water thrown on the soil by canal irrigation) is sufficient to, so far, replenish the land springs as to keep up the level of subsoil water to an inclination of about 1 in 250 at the very margin of a deep drain. A reference to page 27 of No. 81 of Weale's series (Water Works) shows that even with steady pumping from deep

wells round London, the spring line does not assume a less inclination than from 10 to 13 feet per mile.

Captain Home lately showed that a mere growth of weeds has stopped the flow in the Sote nála, Ganges khádir, or at least that the water-level at tail of the Banauli cut has risen. But to my knowledge the water surface of the Soti nala has a fall of two feet per mile.

If weeds can hold up water in this way, it is easily conceived how a continuous layer of sand may obstruct the flow even against a fall of 20 feet a mile.

It can, I think, be explained why canal or rain water will raise spring-level much faster than a deep drain some distance off can lower it.

Thus:—

The water delivered at A, by either the clouds or the canal, has only to sink to B to reach the spring-level; it has the direct force of gravity and capillary attraction to assist it in its descent, whereas the same water to reach C has to traverse the whole resisting medium from B to C.

It is infinitely easier to take the superfluous rain water from A to C by *surface* drainage than through the soil.

Deep drains in England only work efficiently when they are from 20 to 40 feet apart, hence the great expense of thorough drainage as it is called.

The experimental drain in the Chamajhi swamp, East Káli nadi khádir, has done no good beyond drying the surface swamps. In January last we found the spring water within 12 inches of the surface, not 20 feet from the drain; and the ooze at foot of the bángar slope, backed up with the whole subsoil water of the highland, was scarcely perceptible.

These facts seem to show that we should not put much faith in deep drainage, but try and remove the water in detail from the surface before it has time to get into the soil.

J. S. BERESFORD,
Persl. Asst. to Chief Engineer, I. W.,
N. W. Provinces and Oudh.

A new system of reproducing Maps and Plans.

We have been favoured with a copy of a note prepared in the office of the Director-General of Railways, by E. H. S., on a method of reproducing maps and plans by the ferrotypo process. The note says :—

"By this process prints are produced in Prussian blue and white, a print taken direct from an ordinary tracing in Indian ink giving white lines on a blue ground.

"The tracing from which prints are to be made should be on tracing cloth, as transparent as possible, and free from any tinge of yellow. The lines and lettering should be slightly heavier than in an ordinary tracing, and the ink should be thick and opaque. Red lines in carmine or scarlet lake will print nearly as well as Indian ink if the colour be mixed thick. Blue lines will not print. Shading may be done in the usual way in Indian ink either with a brush or in lines.

"*Solutions.*—

A	Citrate of iron and ammonia	...	1⅞ oz.
	Water	...	8 „
B	Red prussiate of potash	...	1¼ „
	Water	...	8 „
C	Carbonate of potash	...	40 gr.
	Water	...	1 oz.

"These solutions will keep indefinitely before mixing, but *A* and *B* when mixed should be used at once or left in the dark.

"*Preparing the paper.*—Mix equal quantities of *A* and *B* and apply to one side of the paper with a sponge. The sponge should be as full as it will hold of the solution, which should be liberally applied to the paper for about two minutes. Then squeeze out the sponge and wipe off all the solution from the surface of the paper, care being taken to use the sponge *lightly* so as to *wipe* the paper thoroughly *without rubbing* or abrading the surface. The paper, which is now of a bright yellow colour on the prepared side, should be hung up to dry in the dark.

"*Printing.*—The printing is done in every respect in the same manner as for ordinary photographic silver prints, the tracing representing the negative.

"Behind the glass of the printing frame lay the tracing, face next the glass, behind the tracing the prepared paper, prepared surface next the tracing. Put out in the sun or diffused day-light until sufficiently printed.

"In bright sun-light from 9 A.M. to noon the time required will be from 8 to 10 minutes. In the afternoon a somewhat longer exposure must be given, increasing as the light gets redder towards sunset. In diffused day-light the time of exposure will be from half an hour to two hours according to the state of the sky and time of day.

"When sufficiently printed the ground colour will be a dark brownish grey, all the lines except the thick ones appearing of a somewhat darker and bluer colour. If the finer lines appear yellow, the print is under-exposed.

"*Fixing.*—The print is fixed by simply washing thoroughly in clean water.

"*Additions and Erasures.*—A white line may be taken out by going over it with a quill pen or brush dipped in mixture *A* and *B*, exposing to the sun, and washing as before. Additions or corrections in white may be made with a quill pen dipped in solution *C*. After using solution *C* the print must be washed, or the lines will spread and become blurred.

"Stains on the fingers may also be removed by solution *C*."

The printing frame is a stout wooden frame with a sheet of glass, on which is laid first the drawing to be spied and then the prepared paper. The whole is then exposed to the light as directed, and the result is a copy of the original, with the difference that the white with black lines of the original becomes blue with white lines in the copy.

Bamboo for Paper, &c.

Bamboo for Paper, &c.

HAPPENING to take up the *Indian Agriculturalist* for 2nd June 1879, containing the report of a meeting at the Society of Arts on March 7th, 1879, I could hardly believe my eyes as I read therein the opinions of some of the speakers.

The exhibition of so much ignorance, by earnest men met to discuss and forward an economic question of moment, was humiliating, and Mr. Routledge himself seemed as much in the dark as any of them.

At page 200 he says: "The young bamboo sprang from the seed of the old plant, and it took about 15 years before it became silicious. No matter what species it might be, it went on maturing for a series of years, and being an endogenous plant, it grew until the inside got filled up and it could grow no longer. It could then no longer transmit the sap, its pores or vessels became ossified, like the veins of an old man, and it died, having first seeded." Now there are some 14 or 15 kinds out here in Eastern Bengal that I know pretty well, have planted Baries and cropped them for some 12 years, yet I must say there is not one single statement in the quotation that is accurate, even approximately.

The bamboos here vary greatly in kind, in size, modes of propagation, in value, &c., but taking the most common and most useful one, the "Jati" (or one with best jât) let us compare notes.

1*st*.—It does not seed, and is propagated, like most others, by a young root and piece of stem 8 or 10 feet long trans-

planted. 2*nd*.—These stocks are of young and not "old plant." 3*rd*.—The bamboo generally becomes silicious (?) at two and three and not fifteen years old. 4*th*.—All species do not take a series of years to mature; some mature in two, others in six to twelve years. 5*th*.—The bamboo attains generally its full height, girth and thickness of walls in one year, and the latter do not grow thicker and thicker yearly, and eventually cause death.

One gentleman—Mr. Cobb—stated that the Chinese "let some grow so large that they make buckets of them"! as we might say of a knowing fellow who let his pony alone so as to grow into a horse! This applied to the "Ming" bamboo of the Nagas, a peculiar species, and if anything larger when young than when old. These I give as samples of the facts guiding (?) the meeting.

It seems to me the best thing Mr. Routledge could have done would be to pick out some two or three of the most likely kinds, clumped or gregarious, cultivated or wild, and have learnt all about them. Instead of this, stray facts, relating to perhaps a hundred species, have been collected, mixed, and poured out, resulting, as we might guess, in a nice *mess*.

Undoubtedly there are enormous areas all through the hill tracts of Eastern Bengal where the bamboo grows rampant, and could supply the demand until it was systematically *cultivated* for fibre, and this, I take it, is the object in view.

Now the leading fact in this case is one that Mr. R. seems not to have grasped, and may account for the divergence between him and Dr. King, *i.e.*, that the most likely cultivated kinds do not propagate by *seed* or from *old* stems, but shoot up from the very kind he wants to cut away, *i.e.*, the *young* stems; cropping the young stems (from which alone pulp should be made) cripples the propagation. What he needs to leave is what he also wants to take away—a case of eating his cake and yet having it.

Even if he takes but a few here and there, it is still the same in the end: what he gains in crop for fibre, he loses in propagation, and this in the cultivated kind is no small difficulty.

This is Mr. Routledge's particular nut, and not an easy one to crack, you would say, if you knew the facts thoroughly.

As it bears on this matter—but also because it may be of use to so many of your readers—I will describe shortly the way to plant a bamboo Bari.

Firstly, the site should be above swamp level, and, secondly, near enough to the station to be watched, so as to keep out pigs, cows, elephants, and *thieves*. If grass land, it may be cleared and burnt, though this is not absolutely necessary; if forest, it should be cleared, and then the lines laid out

about 20 or 24 feet apart, and holes of 2 feet × 2 dug about every 12 or 16 feet in these rows, each hole to take two or three root stocks.

If Jati bamboo is to be planted, the root-stems of young ones should be selected, say of one or at most two years old, and which can be known by the white band round the stem just above each joint. The root should be carefully bared and the stem cut above it at 10 or 12 feet, foliage left on. When dug out the stem and root will look like the letter J, and care should be taken not to injure the eyes on the lower bent part, as it is from these (three or four on each side) that the future bamboos shoot. February or March is a good time, and the early rains in April will prevent these stems drying up. It is a good way to plant these root stems slightly inclining outwards, and have them well tamped in, with some rubbish thrown over as shade for the ground. In the Kachari country and from Borpettah past Nol Bari, Komalpur, and Darang, where there is no building timber, fine bamboo Baries are seen, and in many cases a large square of an acre or so has the outer rows all round of the Buluka bamboo—a stronger kind both as protection from storms and as posts for buildings, bridges, &c.

During the first year very little more may show than an addition to the foliage sprouting from the six or eight joints above the ground; here or there a small whip-like shoot may rise to 16 or 20 feet. In the second year, about the end of June, larger shoots will rise, growing four or five inches per day and up to 20 or 30 feet with girth of four or five inches. In the third year still larger ones will grow, and all the time creepers should be now and then cut away. In the fourth year full sized growth may be expected, *i.e.*, shoots 50 feet high with stems of eight and nine inches round, and the number of such should about equal and double the number of stems first planted. Each year thence should add 50 per cent. to the numbers, if in fair soil, and in the eighth or ninth year there should be some 3,000 full sized stems, mature enough to cut, per acre per annum.

For building purposes or making use in the ground, no bamboo should be cut of less than four years old, and should be steeped a month in water.

"Jaties" increase in value with age up to 12 or 14 years, after which they gradually "dry up," turn yellow and die. If grown in the open they are often short, small and solid; those in shade are tall, large and thinner walled.

If required for tying or rude ropes, only the young ones of one or two years old are used.

From having more water and less wood, they are more easily twisted, and a *whole stem can* be at once used in this way, though it is more usual to split and then twist them. When split up very small it is called "Tougal."

It seems extremely probable that young stems would furnish more and better pulp than old ones. In cutting bamboos out, old ones should be cut at or near the ground, and young ones five or six feet above, as the old ones do not readily throw out shoots or new sprouts, while the young ones do if some foliage is left on, and this leads at once to the solution of the difficulty that lay between Mr. Routledge and Dr. King, *i.e.*, that cropping of the young bamboos (near the ground) cripples the propagation, whereas if two-thirds are cut at say six or eight feet high, enough is left to keep up the supply of new shoots, provided of course the *foliage* is encouraged on the part left. The remaining one-third is left altogether, and only cut when old, *i.e.*, useless for propagation, and useful for building.

I have cut 300 bamboos for one rupee out of a Bari, and as they are often 16 for the rupee in the villages for Tea Factory building, a Bari is a source of great saving, and in a few years pays its cost many scores of times over.

S. E. P.

—*Indian Tea Gazette, 6th August* 1881.

A new system of Impregnation of Timber.

A translation from the "Revue des Eaux et Forêts" for February last, which quotes from the "Journal des Cultivateurs."

THE methods employed for the preservation of wood do not guarantee sufficient durability.

In fact the copper and other salts used remain soluble after injection, and end by disappearing on account of damp, so that after a short time the antiseptic property of these salts is completely lost. Again creosote also fails, since this substance penetrates into the wood to the depth of about a centimetre only, a few cracks suffice to admit the humidity, which necessarily conduces to disorganisation, all the greater on account of being shut in.

There is in this but a temporary preservative action on the part of the salts and creosote; it would therefore be of advantage to replace these agents by the introduction into the wood of fatty substances, which would be transformed into fatty acids, and would thus render the wood completely inalterable, because fatty acids are insoluble in water.

How can we set about obtaining this result? It is quite simple. We have only to inject the fatty matters in the form of soap-water, in the same proportion as that adopted for the saline substances so as to line the fibres of the wood. It is, therefore, simply a question of changing the fatty matter

into fatty acids which is easy, for acids have the property of turning soap-water into fatty acids.

Moreover the soap-water can be introduced into the wood with the same apparatus that serves for the injection of the sulphate of copper. It is, therefore, necessary to inject the pieces of wood, then to evaporate in an oven about half the water which has aided in the introduction of the fatty matter; then to replace this water by sufficiently diluted sulphuric acid; whence two operations, and in consequence various manipulations and increase in the net cost.

To avoid this difficulty it occurred to Mr. Jacques to add immediately on the soap-water injected a quantity of sulphuric acid sufficiently small to ensure its being neutralised during the injection, on the supposition that when the evaporation in the oven has sufficiently lessened the volume of water that has served as a vehicle to the fatty bodies, the sulphuric acid will recover its force of action, and will transform the remainder of the soap-water into fatty acids.

It must not be forgotten that by a result of capillarity the fibres of the wood retain during drying part of the liquid injected, and that in consequence when the chemical action sets in, it takes place in the interior of the fibres. When this transformation takes place, the fatty acids are precipitated in the form of an oily *milk*-like substance, which expands and saturates the fibres of the wood when the evaporation is complete.

Results have confirmed these provisions, since some wood injected has had the fibres lined (garni) with fatty acids as has been stated by Mr. Durand-Claye, Director of the Laboratory of the Committee of Public Works at Paris.

From what precedes we see that sulphuric acid is necessary to produce the transformation of the soap-water into fatty acids in wood, but this acid is not necessary for leather.

It is probable that we shall not be long in establishing in France an apparatus allowing of the injection, not only of mine-posts, hop-poles, planks for flooring, laths for gardens and railings, &c., but also all the pieces of wood used in the machines and plant of cultivators. It will be sufficient merely to dismount these pieces for the purpose of subjecting them to the operation which will render them, so to speak, inalterable.

Already in Germany this process has been used, and we are assured that the French Government is disposed to take up the study of this discovery, with the object of applying it to the preservation of railway sleepers.

It is evident that this system may bring about very important results in case it fulfils its promises. We shall soon know definitely on what we can rely.

Civil Suits and the Forest Code and the law of Cattle Trespass.

TO THE EDITOR OF THE "INDIAN FORESTER."

SIR,—Can you or any of your readers enlighten me as to the reasons for the rule laid down in para. 231 of Forest Code, *viz.*, that sanction must be obtained to the institution of a civil suit? No doubt in case of an important suit involving difficult legal questions, the rule is a good one, and most men would be only too happy to have the responsibility shifted from their shoulders. But there are numerous cases in which an officer might be left to judge for himself, and in these cases the rule acts vexatiously. For instance, when advances are given to petty contractors on agreements, the mere presentation of the agreement in court is sufficient to bring the man to his bearings should he try to shirk. Here the rule necessitates a vexatious delay and unnecessary correspondence.

Again, the same thing, where a purchaser of forest produce at auction fails to pay up. Having purchased the produce under rules duly sanctioned, the conditions of which have been clearly made known to him at the time of auction, surely it should not require special sanction to sue him for the amount due by him.

According to the Cattle Trespass Act damages are recoverable from the owner of trespassing cattle, by simply proving the trespass. Now in a plantation lately started at my headquarters station, we have been put to great annoyance and loss from the trespass of cattle. Out of some 18,000 plants put down last year, less than 5,000 remained at the beginning of this season, the great majority of the remainder having been eaten or trodden down by cattle.

There is a strict law against the killing of cattle in the province otherwise my plantations would long ere this have become a place to be dreaded both by the cattle and their owners. The latter, however, take advantage of this law to allow their cattle to graze at their own sweet will, and actually turn them loose at night. The consequence of this treatment is, that the creatures get as active and almost as wild as deer, most knowing at getting through or over fences and extremely difficult to catch. We do however manage to catch a few now and then, and thus find out to whom they belong.

Driven to desperation, I determined to bring some of the worthy citizens to book, and asked for sanction to sue one of them for damages; but alas for my determination and my poor plantation, I am snubbed in reply, the reason given that it is not seemly or desirable for Government to be frequently appearing in court to sue for small sums.

Now, Mr. Editor, I hope you will condole with me, and if you could give me a hint as to how I am to get out of my quandary, I should be so much obliged.

I suppose you would say "hedges and ditches," but did you ever know them to keep out deer, and I tell you these pampered cattle are just as nimble.

You know, it would not do for me to write back and say it is more undignified for Government to allow itself to be bullied because it won't allow its officers to appear in court now and *then, but I must say "them's my sentiments."*

"ABRUTI."

[We quite agree with our correspondent that in the case of small suits to recover advances it is apparently an unnecessary trouble to obtain the sanction of Government to the institution of a civil suit, but the question has doubtless been properly considered. Perhaps, however, if the *matter* is brought forward officially, Government may be induced to alter the Code, and make it less strict on the subject of *small* suits. There would seem to be no reason why at any rate the Conservator's sanction should not be sufficient in the case of suits to recover amounts of small value, less than, say, Rs. 500 or something of the kind.

On the cattle-trespass question we fancy "Abrah" has his best remedy in the Criminal and not the Civil Court. But we should be surprised if in any province, or, indeed, in *any civilized* country, the law would allow him to kill the cattle, unless *indeed they "attacked" him*

We suppose "Abrut's" plantation is not under the Forest Act, or his remedy would be simple—either to get the fines altered to a sum which would make them a real punishment, or to prosecute for damages to the forest. But his plantation will at any rate come under section 11 of the Cattle Trespass Act, and he can we imagine, either impound the cattle or give the owners notice that he intends to proceed against them for mischief under section 425 of the Indian Penal Code. (see Illustration L under *that* section.) But we have no doubt the law on *the subject* will be carefully explained in Mr. Baden-Powell's Manual which we are daily expecting.—ED.]

The Flowering of the Bamboo.

TO THE EDITOR OF THE "INDIAN FORESTER."

SIR,—WITH reference to the general subject of the flowering of bamboos. In January 1880 in the Chittagong Hill Tracts, I came across a considerable stretch of bamboo forest, covering the entire slope of a hill. The ground was literally covered with the dead rotting stems of a large bamboo, so much so as to render walking difficult, while a full crop of young shoots, about 10 feet high, had already taken the place of the old ones.

The bamboo was the "*Orah*" (*B. Brandisii.*) At first I *thought that the hill-side had been cleared for jhum* cultivation, and for some reason abandoned before the cut jungle was fired, but soon saw the real state of affairs.

This bamboo I had found flowering the previous year, but generally in isolated stems; here it covered large areas to the exclusion of all else except a solitary tree here and there.

Seed obtained from this bamboo germinated fairly well.

E. G. C.

[In 1874-76 the *Goba* bamboo of the Sikhim hills (*Cephalostachyum capitatum*) flowered *throughout and died* off. The stems were mostly then burnt in jungle fires and hillsides formerly clothed solely with bamboo, grew up *in tree forest.* Seedlings of the *Goba* have again appeared, but in far less quantity than formerly. It may be well to record this information while the subject is being discussed.—ED.]

The Male Bamboo.

TO THE EDITOR OF THE "INDIAN FORESTER."

SIR,—CAPTAIN WOOD's note on page 53 of your July issue has put me in mind of a point concerning which I have frequently wished to consult your readers. Why is *Dendrocalamus strictus*, Nees, called the "male bamboo"? The Forest Flora of North-West and Central India, on page 563, gives this as the English name of the species, and says that the stems have a small cavity, or are entirely solid. I have never myself seen a stem *entirely* solid, though I have no doubt there are such. I have seen many with a very small cavity, and many more with a large cavity. The members of the Nagpur Hunt Club in my time were wont to use as spear shafts *almost solid* stems of *Dendrocalamus strictus*, as solid as they could get them, and I remember in 1877 supplying the local, but celebrated spear-maker, Boput of Nagpur, with about one hundred shafts of the almost solid stems of this bamboo; they came from the Moharli Forest of the Chanda Division, but there they were only found in one particular tract, on Vindhyan sandstone, which had been preserved from fire for some years previously. Boput told me at the time that the only other place where he could procure sufficiently solid stems was a certain forest in the Chindwarra District, the name of which I have forgotten. This tends to show that the solid, or almost solid, stem of this bamboo is not common, at least near Nagpur.

It is this kind of stem, used for spear-shafts, which I have always understood to be the male bamboo. How is it that the name of male bamboo is applied to the entire species?

With reference to the concluding paragraph of Captain Wood's note, would it not be far more useful to record data about the seeding of bamboos, and indeed of forest trees, in the pages of the "INDIAN FORESTER," than to consign them to oblivion in Progress Reports? Progress Reports take a long time in coming out, are concerned chiefly with statistics of work done, and of money paid and received, and as a rule only interest a very small body of readers. Matters of universal forest interest should be sent to the "INDIAN FORESTER," where, I am sure, they would be welcomed and appreciated.

A. SMYTHIES.

We have seen some in Chota Nagpore, which, if not throughout, had most of the lower joints completely solid. We are inclined to agree with both of our correspondents in their views regarding the publication of information, and to recommend record both in our pages and the official reports. Boput might another time try Palamow or Koderma.—ED.]

Useful Tables for the Height of Trees and the Reduction of Ground to base measurement.

We have been favored by Major Bailey, R.E., the Director of the Forest School, with copies of some tables which he has prepared, and which may prove useful to some of our readers who may like to have ready in a handy form tables which will save a considerable amount of calculation.

To find the height of a tree from a base (measured from its foot) of 50, 100, 150, *or* 200 *feet, the angle subtended by the tree being observed.*

Angle.	Base in Feet.				Angle.	Base in Feet.			
	50	100	150	200		50	100	150	200
12°	11	21	32	43	38°	39	87	117	156
13	12	23	35	46	39	40	81	121	162
14	12	25	37	50	40	42	84	126	168
15	13	27	40	54	41	43	87	130	174
16	14	29	43	57	42	45	90	135	180
17	15	31	46	61	43	47	93	140	187
18	16	32	49	65	44	48	97	145	193
19	17	34	52	69	45	50	100	150	200
20	18	36	55	73	46	52	104	155	207
21	19	38	58	77	47	54	107	161	214
22	20	40	61	81	48	56	111	167	222
23	21	42	64	85	49	58	115	173	230
24	22	45	67	89	50	60	119	179	238
25	23	47	70	93	51	62	123	185	247
26	24	49	73	98	52	64	128	192	256
27	25	51	76	102	53	66	133	199	265
28	27	53	80	106	54	69	138	206	275
29	28	55	83	111	55	71	143	214	286
30	29	58	87	115	56	74	148	222	297
31	30	60	90	120	57	77	154	231	308
32	31	62	94	125	58	80	160	240	320
33	32	65	97	130	59	83	166	249	333
34	34	67	101	135	60	87	173	260	346
35	35	70	105	140	61	90	180	271	361
36	36	73	109	145	62	94	188	282	376
37	38	75	113	151	63	98	196	294	393

The height of the stem to the level of the eye must be added to the figures given in the table.

To find the height of a tree from a subtended angle of 20°, 30°, 40°, 50°, *or* 60°, *the distance to the foot of the tree being measured.*

Base.	Subtended Angles.					Base	Subtended Angles.				
Feet.	20°	30°	40°	50°	60°	Feet.	20°	30°	40°	50°	60°
50	18	29	42	60	87	102	37	59	86	122	177
52	19	30	44	62	90	104	38	60	87	124	180
54	20	31	46	64	94	106	39	61	89	126	184
56	20	32	47	67	97	108	39	62	91	129	187
58	21	33	49	69	100	110	40	64	92	131	191
60	22	35	50	72	104	112	41	65	94	133	194
62	23	36	52	74	107	114	41	66	96	136	197
64	23	37	54	76	111	116	42	67	97	138	201
66	24	38	55	79	114	118	43	68	99	141	204
68	25	39	57	81	118	120	44	69	101	143	208
70	25	40	59	83	121	122	44	70	102	145	211
72	26	42	60	86	125	124	45	72	104	148	215
74	27	43	62	88	128	126	46	73	106	150	218
76	28	44	64	91	132	128	47	74	107	153	222
78	28	45	65	93	135	130	47	75	109	155	225
80	29	46	67	95	139	132	48	76	111	157	229
82	30	47	69	98	142	134	49	77	112	160	232
84	31	48	70	100	145	136	50	79	114	162	236
86	31	50	72	102	149	138	50	80	116	164	239
88	32	51	74	105	152	140	51	81	117	167	242
90	33	52	76	107	156	142	52	82	119	169	246
92	33	53	77	110	159	144	53	83	121	172	249
94	34	54	79	112	163	146	53	84	123	174	253
96	35	55	81	114	166	148	54	85	124	176	256
98	36	57	82	117	170	150	55	87	126	179	260
100	36	58	84	119	173	152	55	88	128	181	263

The height of the stem to the level of the eye must be added to the figures given in the table.

Deduction from each chain of a distance measured on a Slope to reduce it to a measurement on a horizontal plane.

Slope.	Deduction Links	Slope.	Deduction Links.	Slope.	Deduction Links.
1°	0·02	18°	4 89	35°	18 08
2	0·06	19	5 45	36	19 10
3	0·14	20	6 03	37	20 14
4	0 24	21	6 64	38	21 20
5	0 38	22	7 28	39	22 29
6	0·55	23	7 95	40	23 40
7	0·75	24	8 65	41	24·53
8	0·97	25	9 37	42	25 69
9	1 23	26	10·12	43	26 86
10	1 52	27	10 90	44	28 07
11	1·84	28	11·71	45	29·29
12	2 19	29	12 54	46	30 53
13	2·56	30	13 40	47	31·80
14	2·97	31	14 28	48	33·09
15	3 41	32	15 20	49	34 39
16	3 87	33	16 13	50	35·72
17	4 37	34	17 10		

Producing fire by friction.

THE following method of procuring fire, used in the Chittagong Hill Tracts, differs considerably from that quoted in your last issue from Mr. Ball's paper.

A piece of bamboo, about 10 to 12 inches long, and an inch in diameter, is cut and split into two. One of these pieces is then taken and a small notch cut in the convex side so as only just to penetrate right through. A little tinder is then procured by filing a bamboo with the "dao."

A fine strip of bamboo of about a foot or more in length, and of about the thickness of a piece of string, is prepared.

The split bamboo is then placed on the ground, concave side upwards, and held in position by the operator's toe. The tinder is placed on the notch in the hollow of the bamboo, and the string passed underneath and worked backwards and forwards in the notch. The motion at first slow becomes faster, and the tinder smokes. By this time the string generally breaks, and the man, blowing on the tinder, in a little while brings it to a state of incandescence. A few leaves are gathered and a fire is lighted.

I have on several occasions in the forests, after forgetting or consuming my matches, made one of my coolies produce a light for my pipe in the above manner. I have tried it once or twice myself, but although it is easy to make the tinder smoke, I could not produce fire.

E. G. C.

JJ. Official Papers.

The American India-rubber trees at Nilambur.

Letter from R. Cross, Esq., to the Conservator of Forests, Madras, dated Ootacamund, the 6th March 1881.

Respecting my previously-arranged journey to visit the sites proposed for the cultivation of the various species of American India-rubber trees, I beg to state that I proceeded on this duty on February 15th, and arrived at the bungalow at Nilambur *on the evening* of the 17th. The course pursued was by Naduvatam, Gudalur, and Nadgani, descending afterwards by the Carcoor Ghat to the plain land below.

On the following day, accompanied by Mr. Ferguson and Mr. Hadfield, his successor, I visited the site of the newly-introduced rubber plants. These have been planted in an open space of teak forest land on the bank of the Nilambur river.

The first sort examined was that which furnishes the rubber known in the market as "Ceara scrap." The tree belongs to the Mandiocca family, and the roots are furnished usually with tubers, *which vary in size and number in* accordance with its growth. The plants of this sort have, in the brief space of two years, shot up in the most surprising manner, the highest upwards of 30 feet in height, and are now yielding an abundant crop of seeds. I was shown one strong rank sapling, which, in five months from the time of planting, had grown up and produced flowers.

This region is, without doubt, admirably adapted for the growth of the tree; and the robust and vigorous appearance of those already planted is certainly quite equal to any trees of the same *apparent age and size I saw when engaged in collecting* the original plants near Ceara on the coast of Brazil. At the same time I would confine the general planting of the Ceara rubber to rather dry, arid situations and poor soils, reserving the good, deep, moist sandy loam of the Nilambur river and its tributaries for the *Castilloa*.

Mr. Ferguson was desirous of proof of the actual existence of rubber in his Ceara saplings; and, although these were too young to yield this product, I resolved to make an attempt to satisfy him. The natives at Ceara, in bleeding this sort, simply slice off the *outer portion of the bark on one side of* the tree from the base to a height of four or five feet. The milk exudes from the pared portions of the trunk and runs

down in little courses. By the following morning the milky juice of these courses is sufficiently solidified to be pulled from the tree in strings, which are rolled up into balls as the work of collection proceeds.

When this process was tried on one tree the milk exuded freely, but next day on examination it was found that the greater portion had evaporated, showing the watery and immature state in which the milk exists in young growing plants. However, on making incisions on the collar and largest roots of the plants milk of good quality was obtained, which next day was found coagulated. From the collar of five saplings about an ounce of rubber was obtained, which, in appearance, elasticity and odour, could not have been distinguished from "Ceara scrap" as seen in commerce. But it is manifest that the trees ought to be allowed to attain some size before being wrought.

The propagation of this sort is as easy as a willow. I made a few cuttings just to show the proper method, and these were planted near the bungalow. But now that the trees are producing seed, recourse to cuttings may not often be necessary. Each seed before sowing should have a small portion of the outer shell broken off by a pair of pincers, simply to allow the moisture to reach the embryo, which in the operation should not be injured, or by merely burying the seeds in moist sand germination will take place much earlier.

THE PARA RUBBER.—This rubber tree, which yields a valuable commercial product, has seemingly not found its proper habitat at Nilambur. The young plants have shot up like long whip-handles with a bunch of leaves on the top. There is not, however, the slightest reason to despair of success. Some plants, say a dozen, should be planted in the Carcoor Ghat at an elevation of 1,000 feet, and another dozen might be put down at 2,000 feet or, for example, somewhere in the vicinity of "Campbell's Rock." A little clear site at each place, a few yards in extent and easily reached from the road, would suffice for these experiments. The Para tree is easily multiplied, and recourse may be had to the same way as that adopted for willows. I made some cuttings, which were planted in a moist situation on the river bank. From these it may be seen whether additional humidity improves the character of the plant.

CENTRAL AMERICAN RUBBER.—The *Castilloa elastica*, yielding this description of rubber, and of which there are only three plants, has evidently found a home on the bank of the Nilambur river. It may be considered premature to judge or form an opinion from the appearance of only three plants, from three to four feet in height, and indeed this is so. But besides having looked carefully and attentively at the physical appearance and development of these plants, I have considered and remembered the characteristics of the extensive region inhabited by this

tree. The *Castilloa* is found growing throughout the Central American Republics always at low elevations, and certainly I do not think I noticed it anywhere above an elevation of 2,000 feet. North of the Equator, it is met with in the wooded districts, which bound Jambico in Mexico, extending southward through the dense exuberant forest regions of the Central American Republics and stretching across from the Atlantic to the Pacific on as far as the river Atrato, after which it is confined to the forests and base of the mountain ravines bordering on the Pacific coast, and thus continues to Santa Rosa and Arenillas near Tumbez districts, which lie adjacent to the Peruvian desert. Throughout this vast expanse of country there is, without doubt, considerable variation of climate. But it so happens that the periods representing the wet and dry seasons coincide in a remarkable manner, at least as far as I can learn, with the occurrence of the same periods in the Western Ghats. *In the region of the Castilloa*, especially on the Pacific side, the dry season sets in about the beginning of January and continues until April. During this time the rank swamp growth is occasionally so dry that it is set on fire and burned. In the dry season the tree becomes deciduous, and in March pushes forth a fig-shaped fruit, which ripens with a beautiful scarlet crown, all the rest remaining green. In August the fruit is ripe during the heavy rains. The seeds cannot be dried, and must be planted as soon as the fruit falls. It is not found growing on swamps or inundated land, but on the flat moist banks of rivers and steep sides of ravines, where the roots may be seen running down the banks for a distance of 15 or 20 feet to the very margin of the streams.

The *Castilloa* is the largest known rubber-producing trees, its massive trunk sometimes rising in close humid spots to a height of 80 feet clear of branches, and is only exceeded by the "Quipo," a gigantic species of *Bombax*. Sometimes the trunk divides into two stems, evidently from the leading bud *having been broken when young, and those trees are less prized* by the rubber collectors. In order to extract the milk, the usual course is to cut the tree down and make notches round the trunk at about a foot apart. Broad leaves or calabashes are then placed underneath these into which the milk drops. In a few localities, especially at Nicaragua, the trees are not felled. The practice is to make a perpendicular channel in the bark from the base of the trunk upwards, and then make a number of cuts on each side leading into the main channel. A good deal of milk always adheres and solidifies in the primary and side channels, which is afterwards collected. These "dregs" are much valued in the markets of the United States. I have heard it argued among the natives that it was probably more profitable to cut the tree down than trust to the bleeding channel process. My own opinion is, that the channel

method is good, specially for the *Castilloa*, but the collectors gash the trees so badly in working that the after-flow of milk is much lessened. Besides, at the base of the main channel, they drive an iron spout into the trunk in order to convey the milk from the tree to the calabash. A piece of bamboo, luted by means of clay to the base of the channel, would serve the same purpose just as well, whilst the wood of the tree would scape permanent injury. In combination with the channel process, collecting by the cup method will often be found useful, especially in the case of large trees, as cups can be applied to various parts of the tree, which, if operated on by channels, would result in the loss of much milk. I have described the cup process in my report to the India Office on the collecting of Para rubber plants with date of 1877. Respecting the quantity of rubber which may be obtained from a tree, the amount would depend on the age and size of the tree, season, habitat, and likewise mode of collecting.

During the rainy season the flow of milk is greater, and this also is the case with trees growing in humid localities. The skill and care of the collector must also be taken into account; some spill and waste a great deal of milk.

A *Castilloa* tree, if carefully and judiciously tapped with a diameter of 1½ to 2 feet, may be expected to yield about 12 pounds of rubber per annum.

Of all the different species of rubber-producing trees, the *Castilloa* should prove under cultivation the most remunerative. The banks of the Nilambur river and its tributaries afford, in my opinion, suitable sites for planting; and I have no hesitation in stating that the lower portions of the Carcoor Ghat would grow and sustain as fine *Castilloa* trees as any district of Central or South America. The conditions on the bottom and deep side ravines of the Carcoor Ghat are of the most superb description. But no doubt many excellent sites exist along the course of the Western Ghats southward towards Sispara, and likewise to the northward in the Nagar region. In planting the land should be cleared so that the trees may grow up robust, but there will be little mamatie work; for, once the *Castilloa* gets up, it will overtop the majority of the Ghat trees.

The propagation of this sort from a limited stock will require more skill than would be necessary for multiplying the Ceara or Para rubbers.

As yet that plant at Nilambur present few materials for propagation, though, as the growth of the tree is rapid, a supply of cutting shoots will probably be available after the burst of the monsoon. By erecting a small platform, we were able to lay a branch with seven shoots, so that when these are rooted the stock will be at once fully doubled. I would certainly advocate the multiplication by cuttings of the *Castilloa*,

as it is not an early seeder. In America the trees do not usually bear seed until they are about eight years old. Before the lapse of such a period, thousands of *Castilloa* plants might be growing up into young trees at Nilambur, derived by means of propagation. I regret to state that time did not permit me to visit the Silent Valley as a special site for the *Castilloa*. I have no doubt, however, that it will be found well suited for the growth of the tree.

I returned to this place on the 25th of February.

In conclusion, I trust the way in which this duty has been performed will meet with approval.

Copy of a despatch from the Secretary of State for India to the Government of Madras, No. 21, *dated the* 21*st July* 1881.

I learn with satisfaction from the copies of the Proceedings of Government which accompanied Your Excellency's letter No. 6 of the 19th May last, that Mr. Robert Cross, who was deputed to visit the Cinchona Plantations on the Nilgiri hills and the American Rubber Plants at Nilambur, has been able to report favourably upon them. Well acquainted as he is with the habitat of both these plants in Southern and Central America, and their introduction into India being greatly due to his enterprise and ability, I attach importance to his opinion that Southern India is a perfect field for the cultivation of the various commercial products of tropical America, and that the banks of the Nilambur river and other sites along the course of the Western Ghats are as fitted as any district in Central or Southern America for the growth of the *Castilloa* trees, which, of all the different species of rubber-producing trees, should, he considers, prove the most remunerative.

2. I agree with Your Excellency that Mr. Cross's reports are valuable additions to the information already recorded on the subjects with which they deal, and I approve of your action in retaining his services in India until such time as the *Calisaya de Santa Fé* plants may be considered sufficiently established and safe from all ordinary risks.

The Burma Forests Bill.

The following is the report of the discussion which took place on the bill in the Legislative Council on the 31st August 1881:—

BURMA FORESTS BILL.

The Hon'ble MR. RIVERS THOMPSON presented the report of the Select Committee on the Bill to amend the law relating to forests, forest-produce and the duty leviable on timber in British Burma, and moved that the Report be taken into consideration.

The motion was put and agreed to.

The Hon'ble Mr. Rivers Thompson then moved that the Bill as amended be passed. Before this motion was put to the Council he wished to make a few observations upon some of the more prominent points in the Bill which had come under the consideration of the Select Committee. After its introduction the Bill had been referred to the local Government, and we had received from the Chief Commissioner of British Burma a report which embodied the views of a great many local officers and of the two Conservators of Forests in that province. The whole of the details of the Bill had been very carefully considered and an excellent report submitted. Generally, the Bill, as he had stated before, proceeded on the lines of the Indian Forest Act of 1878, but there were certain particulars in which modifications were necessary to make that law applicable to the particular circumstances of British Burma. In submitting the report of the Select Committee, it would be seen that in a great majority of the points on which local opinion had been expressed, they had adopted the views which the Chief Commissioner, advised by his forest-officers, had submitted for our consideration. But there were one or two important points on which the Select Committee had differed from the local Government, and perhaps it would be as well to draw the attention of the Council to these, without enlarging upon the verbal and other details by which the original Bill had been amended. In the section relating to definitions, two changes of some consequence had been made: one in the definition of "forest-officer," which now included officers appointed by the Government of India, in addition to those appointed by the local Government, because Conservators and Assistant Conservators were appointed by the Governor-General in Council; and a second alteration, which defined "land at the disposal of Government" to mean—

"(*a*) land in respect of which no person has acquired the status of a landholder under section seven of the Burma Land and Revenue Act, 1876;

"(*b*) land in respect of which no person has acquired any right created by grant or lease made by, or on behalf of, the British Government."

That would cover a great deal of the repetition which occurred in the previous Bill, and was therefore not without its value in the understanding and working of a large measure. Again, one of the principal points to which the Chief Commissioner took exception was with reference to section four of the Bill. That section was as follows:—

"Nothing in the Burma Land and Revenue Act, 1876, shall be deemed to affect or ever to have affected any right by which one person is entitled to remove and appropriate, for his own profit, any part of the soil belonging to another person or to the Government, or anything growing in, or attached to, or subsisting upon, the land of another person or of the Government; and nothing in this Act shall be *deemed* to affect the provisions of sections twenty and twenty-one of the Burma Land and Revenue Act, 1876."

And with reference to this section, the Chief Commissioner said :—

"Section four was not in previous drafts of the Bill, nor was it proposed by the Local Administration Its purport apparently is to declare that the Burma Land and Revenue Act did not override or extinguish easements as defined in the Indian Limitation Act, 1877. So far as is known in Burma, no Court of Justice and no person whatever has ever raised any question that would require to be set at rest in this particular way. If it is intended to safeguard the claims of Karens and others who practise *toungya* cultivation, then the only person against whom such safeguarding is needed is the Government Now the provisions of the present Bill and the past history of the Government relations with *toungya*-cutters for the last 25 years show that Government has treated the interests of these people with the utmost tenderness and consideration"

Practically that was the effect of the new section. The Chief Commissioner went on to say :—

"On the general principles that it is a great pity ever to make a law that is not shown to be needed, and that it is inexpedient to create by legislation vague undefined rights or claims, the scope of which cannot be foreseen, the Chief Commissioner and his officers strongly advise that this section be omitted"

However, in considering the subject, the Select Committee came to the conclusion that it was necessary to retain the section; because, though the Land Revenue Act of British Burma referred to easements as acquired under the Limitation Act of 1871, it did not cover the more extended definition of easements as defined in the later law of 1877, and as it was indisputable that such rights did exist in Burma, and that they were in fact the particular claims to which the attention of forest settlement officers had to be directed, it was absolutely necessary by this addition to secure that those easements should be saved, and the section was simply therefore a declaration of the law as it at present existed.

In section eleven a material addition was made in the Bill, in connection with the claims relating to the practice of *toungya* cultivation, and how they were to be dealt with. The Council were aware that the system of *toungya* cultivation was one which extended to different parts of India. We found it under different names in Bombay, Assam, Bengal and elsewhere, and it was generally acknowledged that it was a very wasteful and destructive system of cultivation. He would best describe it as it was worked in Burma in the words of the Chief Commissioner. He said :—

"It may be well to explain here what an ordinary *toungya*-cutter's proceedings are. He cuts down the forest on three to five acres this year, burns the timber and brushwood when dry, sows his rice in the ashes, and reaps it in the cold season. Next spring he will go on to another plot of forest and treat that in the same way. Meanwhile bamboos and underwood grow up on the plot he has abandoned. For a period of seven to fourteen years he takes up new plots of forests, and at the end of that period he may return to his or some of his neighbour's old clearings and begin the process over again; or he may, if the spirit moves him, go off to another valley and cut *toungyas* there, returning after twenty or twenty-

five years to his old ground. It has been argued, and it is even now held by some, that the *toungya*-cutter has rights of property in the areas of forest he has cut down in past years and in the land he cultivates each year, just as an ordinary ryot has in his fallow land and his rice land. The Government of India has repeatedly repudiated this view; and, indeed, the view cannot be accepted if we are to preserve the forest at all in the interests of the general population, present and future. The provisions of the present Bill and the whole history of our dealings with *toungya*-cutters in reserves show that the Government and its officers are scrupulously careful to treat these people tenderly. Paragraphs 118 and 119 of Mr Brandis' valuable report of 1881 on the Burma Forests enter fully into this matter and give illustrations. But at the same time, while the *toungya*-cutters are treated well, it is most undesirable that doubts should exist whether or not these people have not rights of landholders, or rights of property in the forests they cut down. And, therefore, it is proposed to set these doubts at rest by the additional section now submitted."

And the additional section which he (the Chief Commissioner) proposed declared that the *toungya* practice did not convey any right over the land.

The necessity for such a declaration in the present Bill was not apparent, for it could not be overlooked that in the Land Revenue Act of British Burma there was a provision especially which saved every practice of that kind from giving rights such as it was now wished to protect by a special section in the Bill. Under the twenty-second section of the Land Revenue Act it was expressly provided that no person could acquire, by length of possession or otherwise, any right over lands which had been allotted by the rules framed under section 21 to tribes or families practising *toungya* cultivation.

It would, therefore, be mere surplusage to add to the present Bill any section merely expressive of such a declaration, and the Select Committee had decided not to include it. However they recognized, as the Chief Commissioner and any one acquainted with British Burma would recognize, the valuable assistance which those *toungya*-cutters afforded to Forest officers in a great many matters; and, therefore, section eleven provided for the complete investigation of all claims relating to this method of cultivation in land which was to constitute a reserved forest, and enable the forest settlement officers to prescribe the limits within which the practice might be carried on and continued.

MR. RIVERS THOMPSON would also draw attention to Chapter III of the Bill, which was a new one, and related to the constitution of village-forests. There were at present no village-forests in Burma, but it was thought desirable that Government should take the power of assigning certain areas of its own in the neighbourhood of villages for the use of their inhabitants, under the condition that teak or other specially reserved trees should remain the property of Government. The establishment of such forests would be a great boon to the people; and it had been found by experience that

it was quite possible in Burma to combine the protection and good management of a teak-producing forest with a free user of bamboos or other woods required by the people for all domestic purposes.

The chapter to which he now alluded would give the Chief Commissioner the power of constituting such village-forests and regulating the use of them.

Referring to Chapter IV of the Bill, the Chief Commissioner proposed to maintain the ancient and universally recognized right of the State to all teak trees, wherever situate, for a period of five years, that is, for such time as would enable the Government to utilize the valuable trees, after which he considered the right might be conveniently abandoned. At the same time he thought that all teak trees situated in land at the disposal of Government within the meaning of the definition should always be reserved. As the Government rights in the teak tree as a royal tree are recognized in Burma, even when the tree stands on land the property of a private person, the Select Committee had agreed that these rights should be provided for in the Bill, and we have, therefore, in section 35, declared all such trees to be the property of Government. It was thought, however, that, instead of declaring, as proposed, that teak trees standing on land not at the disposal of Government should be abandoned at the close of a fixed period of five years, it would be advisable to give the Chief Commissioner power to declare that such trees shall cease to be the property of Government and to be reserved trees. If it were enacted that the teak trees should cease to be the property of Government at the end of five years, the Conservator would probably be compelled to sell a great number of them at one time, and, perhaps, at a time when the price of teak timber was low. It seemed unnecessary to incur the risk of a loss of Government property. The Bill, as drawn under clause (*c*), section 35, confers upon the Chief Commissioner ample power to deal with the matter as the circumstances in each case might require.

He did not think he had any other observations to make with reference to the Bill. The subject had been under consideration by the local Government for several years, and since its return to us here had been carefully reviewed both by Mr. Brandis and Mr. Baden-Powell, and in all its details had been thoroughly scrutinized by the Legislative Department.

The motion was put and agreed to.

V. Notes, Queries and Extracts.

We have received a copy of Dr. Warth's report on the manufacture of iron, and the future of the charcoal iron industry of India. As we have already published Dr. Warth's report on the Dechauri works and other papers referred to in the present report, which is written with the view of examining the question of how far possible it will be to utilize the less valuable products of our forests, the minor class trees for which no ready sale exists in the manufacture of charcoal for iron-smelting, we need not reproduce much of the paper. The result is evidently unfavourable, for Dr. Warth concludes his paper by saying: "To give a reasonable hope of success there must be a permanent supply of cheap charcoal, good ore *and lime* in plenty on the spot, as well as ample and willing labour, and the locality selected should not be too near the seaports where English iron comes, nor should it be far from a considerable market." For any place to unite all these conditions would be wonderful, and so we fear the idea of utilizing the less valuable kinds of forest trees in iron-making will have to be given up. And this is a pity, for the idea is eminently a good one, and any manufacture which would utilize the class of trees of which we speak, would be a great assistance in the amelioration of the stock of timber in our forests. We know ourselves many localities in which iron could be made, but then the lime is wanting, or the large market or the distance from the sea, and so the idea of working the fine ores must be given up. It is all very well too to say—make your charcoal of the less valuable kinds; but this is not always what is done in practice. The native iron-smelter in the sál forests, as for instance in Chota Nagpore, makes his charcoal of sál, and it would probably require considerable persuasion to get him to give up his habit and take to other kinds. But still if other conditions suit, this too might be managed.

Forest Exhibits at the Departmental Exhibition of Epinal.—The visitors' attention is drawn to a charming chalet surrounded by huge oaks and gigantic firs. This little masterpiece of rustic woodwork, the "Jewel of the Exhibition," as the prefect called it, was built by M. Volf, a cabinet maker of Epinal, after the designs of M. Marie, Sub-Inspector of Forests. Round the chalet groups of forest trees and shrubs have been arranged, and a well stocked nursery has been added.

Inside the chalet the special products of the Vosges forests have been placed, and these have been artistically arranged

and diversified by specimens of some natural curiosities. Among the most remarkable products we may mention woods employed in the manufacture of bobbins, shuttles and musical instruments, and panels of the Weymouth pine which shew what can be done with a wood which it is usual to consider of inferior quality.

The parasitic forest fungi, so little known even yet, are exhibited in a case, opposite which may be seen a curious collection of the minerals of the Vosges. Most of the forest officers in the department have contributed something rare or curious, and the forest service as a whole has more than ever displayed the *esprit de corps* so specially kept up in the Vosges, and shown how many are the ties which attach it to the agricultural and industrial prosperity of the country.—*Revue des Eaux et Forêts.*

We extract the following letter on the variations in the weight of a tea box from the *Indian Tea Gazette* :—

Sir,—As the difficulty of correctly tareing boxes is considerable, I enclose you actual weight of an empty tea box and Lid, on the day it was made up, and at 17 days after, to show by actual facts some of the drawbacks planters have to put up with in these matters :

Weight of full-sized box and lid—

Nov. 6th—30lbs.	Nov. 15th—17lbs.
7th—29	16th—16¾
8th—28	17th—16½
9th—26¼	18th—16¼
10th—24½	19th—16
11th—23	20th—16
12th—22¼	21st—15¾
13th—19¾	22nd—15½
14th—18¼	Dec. 6th—15¼

The box was a very good one, and of a set of simul ones, at Re. 1 each made up, and all from a contractor.

4th June 1881. Sir.

For an empty box to lose 50 per cent. in weight in one month seems extraordinary. We can only account for it in the supposition that the box was cut out of quite wet wood and was dried in the factory.

We have received copies of a recent order of Government, reorganizing the distribution in grades of the Conservators of Forests, as follows :—

1st grade ...	...	on Rs. 1,400—2
2nd „ ...	...	„ 1,200—4
3rd „ ...	...	„ 1,000—2
		„ 900—1
		„ 700—1

An Australian hardwood, called the "Bean Tree," hitherto unknown in the English market, was introduced to the notice of the trade at Messrs. Churchill and Sim's furniture wood sale on Wednesday last. It is a dark, heavy wood, in colour somewhat resembling walnutwood, and is suitable for all cabinet purposes. The figure in the polished samples shown by the brokers, which we have inspected, is very fine. The logs, which were in the ground, and sold by calliper measure, changed hands at 2*s.* 6*d.* per foot cube, and the planks at 4*s.* Should the "bean tree" find favour with cabinet-makers in the country, and a remunerative price be offered for it, we are informed that a regular and plentiful supply can be brought forward, and from the examination of the samples, there appears to us no reason why it should not take its place amongst the woods in ordinary use for cabinet purposes.—*Timber Trades' Journal, 30th April* 1881.

The new law of reboisement in France has been passed at the first reading, and without discussion by the Chamber of Deputies.

We hear that M. Broillard, Professor of Forestry at the Forest School at Nancy, and author of several valuable works on forest working scheme, has now left the School and been appointed Conservator of Forests at Macon. We can imagine that he will be glad to get back to regular work after so long a time spent in teaching. We have not yet heard who is to succeed M. Broillard at Nancy.

Dr. Brandis has kindly forwarded us a copy of his memorandum on the present condition of the Indian Forests, which is to help Dr. James Brown of Stirling, the well-known author of the "Forester," in adding a notice on the Indian forests to the forthcoming 5th edition of his book. We fear that if we were to give the whole of the memorandum, it might be thought unfair on Dr. Brown, so we will content ourselves with the following extract only, as the words of the Inspector-General correspond to the views regarding the training of Indian Forest Officers (not 'Foresters' *mind*, in either the Scotch or the Indian sense) which have on several recent occasions found expression in our pages :—

"It is here the place to say a few words regarding the arrangements made for the professional education of the officers who are destined for the superior staff of Conservators, Deputy and Assistant Conservators,—in fact of the officers in charge of circles and divisions.

"As the organisation of Forest administration is perfected, all these officers, excepting some of the junior men, who must

commence their practical career as executive officers in charge of Forest Ranges, will be controlling, inspecting and directing officers. The number of these appointments will therefore be limited. It is at present 93, and is not likely to be increased beyond 100 for the provinces under the Government of India. Obviously, these are most important and responsible posts; the men must be gentlemen, and they must have such a good general education as will fit them for high administrative duties. Under existing arrangements, this superior staff of officers is recruited by the appointment annually of a few young Englishmen, who are selected by the Secretary of State for India, on the ground of an examination in mathematics, natural sciences and other branches of knowledge, and after going through a course of professional training in the State forests of the Continent of Europe, chiefly in those of France. Here they learn the methods adopted for administering large Government Forest domains; they become familiar with the organisation of a large public forest service, and, among other professional matters of importance, they learn to appreciate the success attained by the system of natural reproduction.

"From the commencement great care has been taken to maintain an intimate connection between Forest administration in India and in those countries of Europe where large areas of State and Communal forests are managed according to a regular system. In building up the system of Forest administration in India, we have thus utilised the experience gained in those countries by the work of centuries, instead of following the ideas and theories of individual men. The formation of the Government Forest domains in India and the organisation of their management has been a large undertaking; and whatever success has been attained in this matter is due entirely to our having utilised the experience gained in Forest administration in Europe."

STAINING WOOD, says *Carpentry and Building*, may be divided into two classes—the staining or dyeing proper, and a sort of painting in which the colouring matter, in a liquid state, partially penetrates the pores of the wood and is held by them. Dyeing colours the fibres to a greater or less depth, in the same manner as the fibres of fabrics are coloured by the deposition of a coating of colouring matter in and upon them, and occasionally by actually changing the colours of the fibres themselves. Staining, properly speaking, is an exceedingly unsatisfactory method of colouring wood. The pigment usually penetrates but a very little way into the wood. The slightest scratch or abrasion of the surface shows the natural colour. When this happens, as it almost invariably does after a short time, repair is practically out of the question. In dyeing, the colouring matter can usually be made to stain the fibres for some little

distance into the body of the wood, and thus a much more durable colour is effected. In the case of veneers—a piece of wood not over an eighth of an inch thick—it is possible, by careful manipulation, to produce a tolerably even colour throughout the wood. In general wood can be made of almost any desired tint, from red rose colour, through the blues, to black. Most of the bright colours, however, are liable to fade, and their use is not to be recommended.

At the present time, naturally, woods are in great demand, and it is often convenient to imitate the colour of some precious wood upon one less costly. Thus we may, upon cherry or maple, imitate rosewood or ebony. Ebony, in fact, can be imitated upon a great variety of woods; the method of producing the colour, however, must be varied for the different kinds. The books are filled with instructions for producing black walnut stains, and dyeing woods to imitate black walnut. A more useless or senseless practice could hardly be imagined, for black walnut is really the last wood in the world which one would wish to imitate. Its colour is bad, and its only recommendation is that it is easily worked and is considerably harder than pine.

At the present time mahogany is somewhat difficult to get, and it is fashionable to use substitutes for it which are mahoganized. Cherry is one of the most commonly used woods for this purpose. If properly treated, cherry is one of the finest cabinet woods which we have; and it seems almost a pity to use it for imitating anything else, even though it be mahogany. A great number of recipes are given in the books for mahoganizing, but the workman in using them is usually in the dark, because no explanations of the reason for the directions are given. One of the English recipes says, after getting the surface of the wood smooth, rub with a solution of nitric acid and then apply a solution of dragon's blood. The solution is made by dissolving one ounce in a pint of alcohol and adding one-third of an ounce of carbonate of soda or common washing soda. Sulphuric acid will answer just as well. Its office is to darken the wood and prepare it for receiving the dye, which is the dragon's blood. Our own experiments lead us to believe that the only advantage of the washing soda is to neutralize any of the acid which may remain behind. Another recipe calls for the acid treatment of the wood first, which is then followed by a liquid made with two ounces of log-wood, eight ounces of madder, one ounce of fustic, and one gallon of water. This is boiled two hours and then applied to the wood. Unfortunately there are no recipes, so far as we know, which give directions for using logwood, dragon's blood, &c., in the shape in which they are found in the stores. For example, instead of log-wood in chips it is much more convenient to buy a little four-ounce box of the extract of logwood, and instead of

the madder coming in the old form, it can now be obtained in the form of a solid, which is all ready to be dissolved in boiling water. By dissolving separately the logwood, dragon's blood, and madder in water, and then, after getting them of good strength, mixing a little of each and drying on a waste piece of wood, the proper proportions necessary to get just the colour desired are easily found. It must be borne in mind that the logwood gives a purplish tone to the mixture, and that the others, if kept to themselves, will only produce a yellow. The stain, when put upon cherry without an acid being previously applied, will give a sort of dirty yellowish-brown. If the acid is added afterwards the red will speedily make its appearance. Besides producing the red colour, the acid has another effect, which is valuable in imitating old and dark mahogany—it darkens the wood very materially. The greatest amount of darkening can be obtained by brushing the wood with the weak acid and then warming it. The heat intensifies the action of the acid, but if too long continued it is possible to scorch the surface, making it look as though a hot iron had passed over it. Indeed, acid may be used for staining almost any wood a dark brown. It would be possible, by a combination of yellow and red stains, to produce the colour of mahogany on almost any of our common woods. In Dick's Encyclopædia we find the following directions for producing a dark mahogany colour:—"Boil half a pound of madder and two ounces of logwood in a gallon of water; apply with a brush while the liquid is hot; when dry, go over the whole with a solution of pearlash made of two drams of pearlash to a quart of water." We have some doubts as to the action of this solution on cherry, though it might act well enough on other woods. Permanganate of potash is often mentioned as being a good material for imitating certain kinds of wood. It comes in the form of crystals, which are readily dissolved in water. When put upon the wood it penetrates deeply, and produces a pink colour at first, but this, by the decomposition of the permanganate of potash itself, soon changes to a dark brown. This is a durable colour, consisting of a metal oxide distributed wherever the liquid has penetrated.

Many woods get their best colour by age. Among these are mahogany, oak, and cherry. Usually, by imitating the chemical action to which they are subject with time, we may produce the same results quickly. If we wash oak with lime water, or, better yet, aqua ammonia, we darken its colour, as though with age. Lime water also darkens mahogany, and greatly improves the colours of some kinds. It also has an effect on cherry. Maple is a very easily stained wood, but it appears to have been somewhat neglected by those who wish to imitate the more valuable woods. The only colours which we remember having seen upon maple are a dark blue-grey, produced by an iron

solution and a yellowish tint due to the varnish.—*Timber Trades Journal.*

MESSRS. FARNWORTH AND JARDINE, of Liverpool, have sent us a sample of the zapaterawood which they offered for sale recently. This wood is imported from Maracaibo, and we are informed that it is used extensively for rule-making; its colour is precisely that of the ordinary carpenter's rule, a greenish-yellow. It is also used for handles, and other turning purposes, but will not do for engraving. It is a newly-introduced wood, and worth £5 to £5 10*s.* per ton, which seems a low price for a fancy wood of such a hard and close grain. Its specific gravity, assuming water to be 100, will be about 85. We are not aware of the bulk of the logs in which it is imported.—*ib.*

GERMAN papers note the extraordinary increase in forest fires of late. In the Prussian royal forests alone there were 36 fires in 1880. During the first five months of the present year there have already been 25. No reasons are assigned.—*ib.*

THE following paras., extracted from the Review of the Cachar District Report in the *Assam Gazette*, are herein reproduced as likely to be interesting:—

Forest revenue.

The revenue received under "Forests" has much improved, having risen from Rs. 34,878 in 1879-80 to Rs. 47,025 in 1880-81. The increase of Rs. 12,147 is almost wholly due to the establishment of two new toll-stations, established in June 1880 for the levy of royalty and duty on timber brought from the Lushai country and the Government reserved forests. Formerly, only timber and forest produce passing Siyaltek (that is, practically leaving the district) were taxed. Now, the new stations command the routes by which the greater part of the timber imported into the district enters it.

Proposals as to modified permission of *jhuming*.

Major Boyd dwells on the importance, for the sake of forest conservancy, as well as for political reasons, of retaining in the forests a certain number of hillmen, who will be available for labour on objects connected with the maintenance of the forests, and proposes that each village should be allowed an area equal to ten times the present *jhum* in addition to that *jhum* and its homestead; he also proposes that the Dhaleswar reserve, in the south-west of the district, should be thrown open to hillmen, and he suggests the location of a Kuki colony in the neighbourhood of the new site selected for the Chhattachura outpost in the midst of this reserve.

Conservator's views on the subject.

Mr. Mann sees no objection to surrendering to Kuki and Naga *punjis* situated within the reserves their homesteads, existing *jhums* and ten times the area of the latter, provided that the area allotted to each village is strictly demarcated, and the permission to continue in possession of it made contingent on the occupants respecting the limits laid down. As regards the Dhaleswar reserve, he points out that, while much of it consists of low lands running up the valleys traversed by the numerous *charas*, or hill streams, there is on the hills in the interior a quantity of very valuable forest, at present difficult of access (and therefore preserved from the spoliation from which other woodlands in the district have suffered), but which it would be very uneconomical in a region where wood is so valuable as in the Surma valley to surrender. He sees no objection to the surrender of these low lands, which were only included in the forest, on its original constitution as a reserve, in order to simplify the boundaries. He would also permit the location in the forest of the Kuki *punji* which it is desired to settle near Chhatachura on the conditions above stated in regard to other *punjis* of the same kind, *viz.*, the demarcation and allotment for *jhuming* of an area equal to ten times the space required for the annual *jhums*.

Decision thereon.

The Chief Commissioner is willing to accept these views regarding the modified sanction to be given to the habit of *jhuming*, though he desires that it should be worked with great caution. Mr. Place in his report mentions a case where some Kukis received a *patta* for a few acres, under cover of which they made an extensive clearing of the forest; on the other hand, there is hope that by degrees these people may be weaned from this wasteful process of cultivation, as Mr. Place has found some who cultivate "like Bengalis." But such a reform cannot but be worked out very gradually; and, for the present, the Chief Commissioner directs that the area required for the existing villages be demarcated and allotted to them; and that the boundaries of the Dhaleswar reserve be re-adjusted so as to exclude from it the low lands suitable for cultivation. The location of a Kuki colony near Chhatachura will depend to some extent on the decision that may be come to regarding the proposal to push existing outpost to a more forward southern position on the Chhatachura range of hills.

At page 97 of our last issue we referred to the experiments made with the *Broussonetia* seed, and, though under a mistake, stated that it had germinated well at Sitapahar. Since then a further lot of seed has arrived and been sown, and it has come up well at Bamanpokri in the Terai, though the black ants have the unfortunate habit of carrying off the seedlings. At

Kurseong, 5,000 feet and near Darjeeling 6,000 feet it has come up well and promises to thrive better than lower down.

VITALITY IN FELLED TIMBER.—"Mahafiz-i-Jangal," in Vol. II of the "INDIAN FORESTER," page 313, gives instances of latent vitality in teak becoming patent. No doubt many instances might be quoted in regard to other forest trees, but from my own personal experience the two following are the most remarkable:—

(1).—*Lagerströmia reginae*, (*Pyinma*, Burmese).—While engaged, during October 1876, in making over teak timber to the railway engineers at Thoue-zeh, about 90 miles to the north of Rangoon, a log of *Pyinma* lying on a sandbank, was observed to have thrown out numerous shoots. Felled up in the forests, it had been floated down the Thoue-zeh choung, and becoming neaped, was lying high and dry on a sand-bank, making a desperate effort to assert its vitality.

(2).—*Bombax malabaricum* (*Letpan*, Burmese).—About 11½ miles to the north of Shwaygyin in the Tenasserim division, stands a lovely jungle rest-house called Thanseik. During the dry season of 1876-77 it had to be re-roofed, and a ladder, necessary for this work, was made on the spot with two *Letpan* poles, bamboos being tied crossways as rungs. On the work being completed, this temporary ladder was left resting against the end of the "Zayat" or hut.

Now the hot weather of that year was very severe, and no rain fell at Shwaygyin until the 15th of May; as the soil about Thanseik is *laterite*, there was an extra good chance of the *Letpan* poles being literally dried to death.

In this same year, the floods were the highest known. When I put up one night during August at this "Zayat," a five-ton boat could be poled up to the verandah. My surprise was not little when I noticed that the *Letpan* poles of the ladder were flourishing vigorously!

At a police stockade (Thayet-pin-kin-dat in the north-east of the Shwaygyin district, I think), *Letpan* poles were used as posts, and they threw out adventitious shoots, and took good root.—J. N.

VITALITY OF TREE STUMPS.—In respect of the throwing out of shoots a curious fact is noteworthy in the case of *Xylia dolabriformis*, (*Pyingado*, Burmese—the "Iron-wood" of Burma). If felled with axe or "dao," no shoots spring from the stool; whereas they do if the trees be felled with saw.—J. N.

[We should like to hear of some experiments to corroborate our correspondent's statement. As far as our own experience goes, in the only part of this province where the tree is found—Orissa—it coppices very freely indeed, although it certainly is not usually cut with a saw. Most soft wooded trees in moist climates, like Burma and Bengal, will grow easily from cuttings even of good sized wood—*Bombax* poles especially—and even logs of the same tree will readily strike.—ED.]